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MEDIUM TERM ABILITY OF OIL PRODUCING COUNTRIES TO ABSORB REAL G--ETC(U)
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MEDIUM TERM ABILITY OF OIL PRODUCING COUNTRIES TO ABSORB REAL GOODS AND SERVICES

Volume III
Technical Appendices

March, 1976

This study is one of a number done by academic and other research institutions for the Department of State, as part of its external research program. It differs from many of these studies in that it is also supported by the Departments of Treasury and Commerce. This study is designed to supplement the research capabilities of these three agencies and provide independent expert views to policy officers and analysts on key questions with important policy implications.

The idea for this study on the Medium Term Ability of Oil-Producing Countries to Absorb Real Goods and Services was proposed by the Office of Economic Research and Analysis in the Bureau of Intelligence and Research (INR) in the Department of State. The work statement for the project was developed in discussions with officers in the appropriate bureaus of State, Treasury and Commerce, the sponsoring agencies, the National Science Foundation, Council on International Economic Policy, and the Federal Energy Agency. Overall monitoring of the project was under the direction of Warren H. Reynolds, Senior Program Officer in INR's Office of External Research, with the assistance of an interagency working group.

The State Department's External Research Program is planned and coordinated by the Department of State Research Council and managed by the Office of External Research. Comments on this study or queries about State's program may be addressed to:

E. Raymond Platig
Office of External Research
Bureau of Intelligence and Research
Department of State
Washington, D.C. 20520

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MEDIUM TERM ABILITY OF OIL PRODUCING COUNTRIES TO ABSORB REAL GOODS AND SERVICES.

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(10) Gary / Keynon

POLICY SCIENCES DIVISION
CACI, INC.—FEDERAL
1815 North Fort Myer Drive, Arlington, Virginia 22209, Telephone (703) 841-7800

PREFACE

This volume is one of three written under Department of State contract number 1722-520061 on the "Medium-Term Ability of Oil Producing Countries to Absorb Real Goods and Services." The three volumes -- Volume I (Executive Summary), Volume II (Research Findings), and Volume III (Technical Appendices) -- present the result of a major effort by CACI, Inc.-Federal to study the current economic conditions, government policies, development plans, and prospects of the 13 members of the Organization of Petroleum Exporting Countries (OPEC). Based on these assessments, a forecasting model was developed and applied to study the economic growth and absorptive capacity of each of these countries from 1975-1985.

Four members of CACI's professional staff contributed far beyond the call of duty to the successful completion of this effort. Gary Keynon and Farid Abolfathi made outstanding contributions to the development and conceptualization of the study. Keynon, who guided the overall research effort as principal investigator, formulated and programmed the elaborate forecasting model that was used to assess the absorptive capacity of the 13 members of OPEC. He also participated heavily in data acquisition. Among other responsibilities, Abolfathi wrote most of the country studies and directed data acquisition. Margaret Hayes drafted two chapters of the final report and commented on many others. She also helped gather data on selected countries and all data on trade with the OPEC countries. Robert Crain assisted with data collection and contributed greatly to the computer programming and data management.

Members of the interagency working group proved themselves constructive critics throughout the research process. They continually probed fundamental assumptions and provided valuable information that enhanced the research process. Warren H. Reynolds, who served as the contract monitor in the Office of External Research, greatly facilitated efforts to gain key information, gain access to government analysts, and keep the

project on a course that would be most useful to the Department of State. The members of the study team offer their sincere thanks to each of these individuals.

Last, but hardly least, CACI's support staff labored extremely long hours over the seemingly endless drafts of the three volumes. Carol Franco and Nancy Streeter smoothed the prose, standardized the formats, and gently reminded the authors that even social science findings can be communicated with a certain amount of style and grace. However, it should not be assumed that they are responsible for what has survived their efforts. Sharon O'Rourke, CACI's ever resourceful office manager, worked diligently to help meet project deadlines. Ann Yamat and Kathy Harris typed repeated drafts of the report, managing to remain understanding to authors who always wanted to make one last change in what was to have been the final, final, final draft. Again, the study team expresses its thanks.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

LIST OF TABLES AND FIGURES (Cont'd)

APPENDIX A

World Demand for Petroleum from the Organization of Petroleum Exporting Countries (1975-1985)

INTRODUCTION

This appendix reviews and synthesizes existing data and projections on world oil production and consumption and assesses their impact on the demand for oil production of the Organization of Petroleum Exporting Countries (OPEC) from 1975-1985. After discussing several general considerations that can influence the accuracy of the forecasts, oil import needs are reviewed for major world regions. These regional projections are summarized in a third section on the world oil balance.

GENERAL CONSIDERATIONS

Estimating world demand for petroleum for the next decade would be a difficult task even under "normal" pre-October 1973 conditions. At that time, one could assume a constant world income elasticity for energy demand which somewhat eased the task of forecasting. Currently, however, there is far greater uncertainty involved in forecasting energy demand. There are five particularly troublesome sources of uncertainty.

- Overall demand for energy. With price increases and government encouragement for lower consumption, many expected a dramatic fall in demand as consumers began to conserve and switch to more energy-efficient appliances and machines. In 1974, a dramatic decrease in energy consumption occurred throughout the industrial countries. However, this decline was accompanied by a major economic recession and may not have had much to do with conservation. The long-term behavior of energy demand remains largely unpredictable.

- Substitution to non-oil fuels. Many believed that as oil became more expensive relative to other fuels (nuclear, solar, oilshale, tar sands, and coal) there would be a rapid increase in demand for these alternative energy sources. More recently, however, economists have had second thoughts about the substitutability of these sources for oil. Physical limitations, environmental costs, and the price of producing large quantities of energy from them may have been vastly underestimated.

- Rate of discovery of new sources of petroleum. After October 1973, experts predicted a rapid increase in the pace of exploration and development of new sources of petroleum in areas outside OPEC. A few significant oil discoveries have been made in Mexico, Brazil, and India, but these finds have not been major when compared to the oil-rich Persian Gulf. No one knows how long the present feverish pace of exploration for oil will continue or if it will produce large-scale discoveries that could reduce the dependence of industrial countries on OPEC petroleum.

- Oil production in Communist countries. No public source in the West has reliable information on the size, quality, or production cost of Soviet and Chinese oil reserves. Therefore, it is impossible to make accurate forecasts for the potential production or availability of Soviet and Chinese petroleum. Moreover, it is difficult to predict the degree to which the governments of these countries would make surplus oil available for export. Thus, most experts have resorted to speculation or educated guesses when forecasting Soviet and Chinese oil exports. Further, it is impossible to predict the degree to which oil-importing industrial countries are willing to become dependent on Communist countries for oil imports.

- The price of energy. Energy prices have trended upward since 1971, when the first significant oil price increase occurred. A number of economists have considered this situation temporary. It is argued that, sooner or later, this "artificially" high price will lead to oversupply of oil and other forms of energy, causing prices to drop. These arguments ignore the ability of OPEC to adjust its production to world demand and may be optimistic about the elasticity of world energy supply. Nevertheless, they have created considerable uncertainty about future energy prices, the perceived risks involved in developing new energy sources, and oil exploration.

These five problems have led to wide variation in forecasts of petroleum demand and supply. Table 1 illustrates the range of variation among 10 different estimates of demand for OPEC oil in 1980 and 6 different estimates in 1985. It is evident that the range is great (about 50 percent around the mean of 1,515 million tons in 1980 and 1,559 million tons in 1985).

Similarly, Table 2 shows a relatively wide variation in forecasts of the capacity of countries to produce oil. This is not surprising since estimating oil reserves is a very complex process. Alternative standards such as "proved," "potential," or "probable" reserves merely add to the uncertainty about future capacity. Few sources are even willing to project production capacity 10 years into the future.

TABLE 1

Demand for OPEC Oil
(mil. tons, annual)

	1980	1985
Mikdashi:		
1. High		2161
2. Low		0747
W.J. Levy Base Case	1568	
Variation 1	1792	
City Bank	1544	1594
American Universities Field Staff (AUFS)		
- ("Normal")	1917	
- ("Restricted")	1175	
CACI	1640	1810
Morgan Guarantee	1474	
Irving Trust	1230	
Organization for Economic Cooperation and Development (OECD)		
- $6 Case	1630	1843
- $9 Case	1170	1200

Source: Mikdashi (1975), Levy (1975), First National City Bank (1975), AUFS (1974), Ganz (1975), Alexander (1975), OECD (1975), and Table 12 of this appendix.

TABLE 2

OPEC Productive Capacity
(mil. tons, annual)

	1980	1985
OECD	2131	
MIT	2131	
National Petroleum Council	3013	
International Bank for Reconstruction and Development (IBRD)	2425	
AUFS ("Normal")	1917	
CACI	2112	2310

Sources: OECD (1975), MIT Energy Laboratory (1974, 1974a), AUFS (1974), National Petroleum Council (1973), and IBRD (1974a).

FORECASTS OF OIL IMPORTS BY REGION

This section presents forecasts of oil imports for selected major countries and groups of countries for 1980, 1985, and, in some cases, 1990. In the following sections, the range of available forecasts is presented on a regional basis. The regional approach was selected because most available forecasts were made on a regional basis and it represents a good middle ground between country-specific and aggregate, global forecasts. The technique used to estimate the future supply-demand situation of petroleum relies heavily on the results of forecasts made by others.

All available forecasts were considered for the years 1980 and 1985. Their techniques and assumptions were scrutinized to eliminate unrealistic forecasts. Then, based on the latest available information a single projection was made within the range of available forecasts, usually close to the mean of all available forecasts. Where information was sparse, this projection sought to remain conservative.

OIL IMPORTS OF THE OECD REGION

The OECD countries are the most important energy-importing states in the world. Consequently, they receive considerable attention in this appendix. Table 3 presents 17 estimates of the energy consumption of OECD countries in millions of tons (of oil equivalent) for 1980.

Most of these forecasts were made prior to October 1973. As would be expected, there is wide variation among them. The lowest is a relatively old projection made by the European Economic Community (EEC) in 1968. The highest forecasts were made but in the 1970's, prior to October 1973, when it was commonplace to expect a healthy growth rate for the Western economies and, hence, a continuing moderate rate of growth in their energy consumption. In general, the post-1973 estimates, such

TABLE 3

Forecasts of OECD Petroleum Consumption
(mil. tons)

Source and Date of Forecast	North America (U.S.)	Japan	OECD-Europe	OECD Total[a]
EEC (1968)	878 (766)	252-273	580-754	1710-1905
Shell (1969)	1160 (1050)	500	1095	2755
Oil & Gas J (1969)	1158 (1050)	498	1079	2735
OECD (1970)				
1. Low	950	370	900	2220
2. High	1100 (936)	510	1200	2810
ESSO (GFR) (1969)	(874)		944	
Dept. of Interior (1968)	(906)			
Chase Manhattan (1968)	(943)			
Ministry of International Trade & Ind. (Japan) (1967)		319		
Industry Forecast (Japan) (1969)		404		
Japan Petroleum Council (1970)		593		
Econ. Commission for Europe (1969)			769	
OECD (1973)	1209	466	1113	2788
OECD (1975)				
1. Base	1245	478	1141	2910
2. $6 Case	1089	410	900	2445
3. $9 Case	962	385	781	2174
Levy (1975) (Base Case)				2196

[a] Total excludes Australia and New Zealand which are minor consumers of energy.

Sources: United Nations (1974, 1974a), OECD (1975, 1973), and Levy (1975).

as those by OECD (1975) and Walter Levy (1975), are significantly lower than previous forecasts made in the 1970's. The size of the reductions, however, is somewhat arbitrary since there is no accurate estimate for the price elasticity of energy demand.

A recent OECD study (OECD, 1975) of energy prospects is the most detailed and the best documented study of OECD energy forecasts for the 1980's. Its forecasts for petroleum are presented in Table 4 to illustrate a detailed forecast of the oil requirements of OECD countries under alternative assumptions about oil prices. As Table 4 shows, the OECD oil import forecasts, especially those for 1985, are sensitive to changes in the price of oil. Moreover, the forecasts assumed gross domestic product (GDP) growth rates of 4 to 5 percent per annum except for Japan (assumed to be 7 to 8 percent).

In general, the OECD forecasts seem to be very optimistic about the elasticity of demand and supply with respect to price and the substitutability of other forms of energy for oil. This optimism is evident from the wide range of variation in oil import forecasts under various oil price assumptions. For instance, under pre-October 1973 conditions, total OECD oil imports in 1980 and 1985 were forecast at about 2 and 2.6 billion tons respectively. At 9 dollars per barrel, projected imports drop to about 1.1 and 1.0 billion tons. Another indication of the optimism of the assumptions of the forecasts is the fact that, at an oil price level of $9 per barrel, the United States is forecast as a net exporter of petroleum in 1985. Few analysts confidently predict such a situation by 1985.

Table 5 displays data and forecasts of petroleum consumption, production, and imports by the OECD countries for selected years. Where the entries are forecasts, the range of each year's projection is given by listing the lowest and highest figures available to CACI at the time of this writing. In addition, a single forecast was selected for each year as the basis for further analysis. The CACI figure represents the estimate that, in our judgment, was most reasonable and most consistent with the latest trends and studies of the world energy situation.

TABLE 4

Primary Energy Requirement of OECD
(mil. tons)

	1972	1980			1985		
		Base Case	$6 Case	$9 Case	Base Case	$6 Case	$9 Case
OECD-Europe (Total Energy Requirement)	1157	1729	1632	1561	2245	2121	2023
Oil Requirement	731	1141	900	781	1441	1120	967
Oil Imports	718	948	680	545	1190	836	667
U.S.(Total Requirement)	1769	2358	2247	2164	2881	2667	2522
Oil Requirement	825	1123	981	860	1306	1005	870
Oil Imports	255	542	331	141	731	255	(-67)
Canada (Total Requirement)	155	235	220	211	293	272	249
Oil Requirement	84	122	108	102	143	116	100
Oil Imports	(-13)	022	002	(-9)	052	025	(-17)
Japan (Total Requirement)	318	636	577	554	854	758	708
Oil Requirement	245	478	410	385	622	511	456
Oil Imports	247	476	408	382	620	505	448
Australia (Total Requirement)	56	98	90	85	133	120	105
Oil Requirement	28	41	38	35	053	50	46
Oil Imports	12	22	14	12	037	24	20
New Zealand (Total Requirement)	08	11	9	8	14	12	11
Oil Requirement	04	05	4	4	05	05	05
Oil Imports	04	04	4	4	04	05	04
OECD-Total[a] (Total Requirement)	3462	5067	4775	4583	6420	5950	5618
Oil Requirement	1971	2910	2445	2174	3570	2807	2444
Oil Imports	1223	2014	1446	1076	2634	1650	1055

[a] Includes Oceania: Australia and New Zealand.

Source: OECD (1975) Energy Prospects to 1985, Volumes I and II

TABLE 5

OECD Energy Balance (for Oil)
(mil. metric tons)

	1965	1970	1975	1980	1985
Consumption:					
1. Low				2174	2440
2. CACI	937	1440	1820	2350	2950
3. High				2910	3570
Domestic Production:					
1. High				1098	1385
2. CACI	447	563	620	950	1280
3. Low				896	936
Imports:					
1. Low				1076	1055
2. CACI	490	877	1200	1400	1670
3. High				2014	2634

Sources: See Tables 3 and 4, Neil (1975) The Economist (1975c), White et al. (1973), Federal Energy Administration (FEA) (1974), Energy Research and Development Administration (ERDA) (1975), Adelman (1972, 1971), Middle East Institute (1972), Duchesneau (1972), Russell and Bohi (1975), A Tripartite Report (1974), Tsurumi, (1975), Prodi and Clo (1975), Darmstadter and Landsberg (1975).

OIL IMPORTS OF COUNCIL FOR MUTUAL ECONOMIC ASSISTANCE COUNTRIES (COMECON)

Tables 6 and 7 summarize the oil balance of the Soviet Union and East Europe for selected years. In general, the procedure used to arrive at these figures was the same as that of Table 5. However, forecasts for the Soviet Union and East Europe are of lower quality than those for OECD, largely because of the secrecy of the Communist governments. Moreover, the Soviet and East European oil situation is approaching a point where major decisions are required that could have a great impact on the Soviet-East European trade in oil for the next decade. These decisions relate to Soviet options:

- To what degree should Western and Japanese technology be allowed to enter into the Soviet oil industry?
- What incentives should be given to attract Western and Japanese technology to the Soviet oil industry?
- To what degree should the Soviet Union and East Europe become dependent on foreign oil and gas, for example, from the Middle East?
- To what degree is it economically practical and politically wise to allow East European dependence on Soviet oil to diminish?

The extent to which these issues have been decided is presently unclear. The governments involved may be procrastinating to allow new developments to take their course. Eventually, decisions on these areas will have to be made, and they will have a great impact on the future of Soviet and East European oil trade. Hence, current forecasts of Soviet and East European energy demand and supply should be treated with great caution.

OIL IMPORTS OF THE PEOPLE'S REPUBLIC OF CHINA

Table 8 summarizes the oil balance of the People's Republic of China for selected years. These estimates and forecasts should be treated with even less confidence than those of the COMECON countries since there has been

TABLE 6

Soviet Energy Balance (for Oil)
(mil. metric tons)

	1965	1970	1975	1980	1985
Consumption:					
1. Low				450	520
2. CACI	168	241	339	500	650
3. High				550	800
Domestic Production:					
1. High				650	800
2. CACI	243	353	483	580	730
3. Low				560	700
Imports:					
1. Low				-200	-280
2. CACI	-75	-112	-144	-080	-080
3. High				-010	100

Sources: Ebel (1970), Economist Intelligence Unit (1973a), Goldman (1975), Landis (1973), The Economist (1975), Berry (1972), United Nations (1974, 1974a), and OECD (1975, 1973).

TABLE 7

East European Energy Balance (for Oil)
(mil. metric tons)

	1965	1970	1975	1980	1985
Consumption:					
1. Low				105	120
2. CACI	35	64	98	115	150
3. High				142	180
Domestic Production:					
1. High				34	35
2. CACI	15	16	17	23	25
3. Low				20	20
Imports:					
1. Low				071	85
2. CACI	24	48	81	092	125
3. High				122	160
Imports From the Soviet Union:					
1. Low				60	60
2. CACI	21	40	64	71	75
3. High				100	130

Source: Ebel (1970), Economist Intelligence Unit (1973a), Goldman (1975), Landis (1973), The Economist (1975), Berry (1972), United Nations (1974a, 1974b), and OECD (1975, 1973).

TABLE 8

Chinese Energy Balance (for Oil)
(mil. metric tons)

	1965	1970	1975	1980	1985	1990
Consumption:						
1. Low				199	200	320
2. CACI	9	22	75	140	300	700
3. High				160	500	900
Domestic Production:						
1. High				400	800	1500
2. CACI	10	25	85	180	450	1000
3. Low				130	300	600
Imports:						
1. Low				-300	-600	-1180
2. CACI	0	-3	-10	- 40	-150	- 300
3. High				30	200	300

Source: Cranfield (1975), The Economist (1975a), Chan (1974), Park and Cohen (1975), Harrison (1975), Park (1975), Cheng (1976), and Economist Intelligence Unit (1974a).

very little information on the Chinese oil industry since the 1949 revolution. The wide range of forecasts of Chinese oil production is an indication of the paucity of concrete information on Chinese oil needs and capabilities. China is depicted by some commentators as having potential reserves as great as Saudi Arabia. Others suggest that Chinese oil reserves are far more modest and foresee that the huge population of China will consume its domestic production, leaving little for export. Estimation is further complicated by uncertainty about the rate and pattern of China's industrialization and resulting domestic energy consumption. Although China is becoming appreciably more industrialized, the pace of development has been uneven over the last 25 years.

OIL IMPORTS OF LESS-DEVELOPED COUNTRIES (LDC'S)

Table 9 summarizes the oil balance of LDC's for selected years. There is a great deal of speculation about the potential and probable reserves of some LDC's. Few experts expect the discovery of new oil reserves in other regions of the world on the scale of those found in the Middle East. However, many believe there is a great deal of oil in smaller reserves. Speculation is most intense about the prospects of oil in Southeast Asia, the Indian subcontinent, West Africa, and parts of Latin America.

Exploration activities have not been intense and extensive enough for systematic assessment of the oil potential of most LDC's. Other sources of uncertainty in forecasting the energy balance in the LDC's include the size of their future energy consumption and the rate of substitution from their traditional energy sources. Uncertainty is further increased by forecasts, such as those of the World Bank, that foresee a decline in the economic growth rates of most LDC's attributable to the oil crisis. Given the population of countries such as India, even very moderate economic growth rates can lead to significant absolute increases in energy consumption. Furthermore, a number of LDC's with large populations such as Brazil, Egypt, and Turkey have great potential for economic growth.

TABLE 9

LDC Energy Balance (for Oil)
(mil. metric tons)

	1965	1970	1975	1980	1985
Consumption:					
1. Low				310	405
2. CACI	120	200	320	450	590
3. High				540	830
Domestic Production:					
1. High				400	1000
2. CACI	65	100	155	300	585
3. Low				250	355
Imports:					
1. Low				-090	-595
2. CACI	55	100	+165	150	005
3. High				290	475

Sources: United Nations (1974, 1974a), OECD (1975, 1973), Alexander (1975), Economist Intelligence Unit (1974, 1974a, 1974b, 1974c), and FEA (1975).

Arab and Islamic countries, such as Sudan and Pakistan, have greatly enhanced development prospects through economic aid from the OPEC countries.

THE OIL BALANCE OF OPEC: AGGREGATE FORECASTS

Table 10 summarizes the oil situation of OPEC countries for selected years. The forecasts in this table were derived from aggregate data and assumptions made about OPEC as a group, rather than by analysis of individual countries. The results vary from the estimates derived from individual country forecasts presented in Appendix 2. However, the total differences between the two sets of forecasts in most cases are not great.

Little attention has been paid to the domestic energy consumption of OPEC countries since it presently constitutes only 2 to 5 percent of production. This situation will change dramatically by the late 1980's should current industrialization plans be achieved. By 1990, OPEC as a group will be consuming from 11 to 36 percent of its own production capacity.[1] These percentages assume that the domestic oil consumption of OPEC countries during the next decade will increase by average annual rates between 11 and 18 percent. The 11 percent figure is perhaps overly conservative because it is the level the OPEC states achieved during the 1970-75 period. Certainly, the growth of energy consumption in the OPEC economies should, in the next decade, accelerate and remain at a high rate through 1990. During the 1964-69 period, the Japanese economy increased its energy consumption at annual rates of over 16 percent. The OPEC countries, most of whom are importing large quantities of energy-intensive capital and consumer goods, may surpass the Japanese performance. Therefore, the 18 percent annual growth, used as the high figure for the oil consumption of OPEC as a group, appears reasonable.

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[1] Note that production capacity is always greater than actual production. Thus, the percentage of consumption of actual production would be significantly greater.

TABLE 10

OPEC Energy Balance (for Oil)
(mil. metric tons)[a]

	1965	1970	1975	1980	1985	1990
Consumption:						
1. Low				095	155	255
2. CACI	24	35	50	100	220	410
3. High				200	480	800
Domestic Production:						
1. High	(At Max. Capacity)			2500	2600	2500
2. CACI	850	1200	1900	2112	2310	2300
3. Low				1900	2000	1600
Exports:						
1. High	(At Max. Capacity)			2405	2445	2245
2. CACI	826	1165	1850	2000	2090	1890
3. Low				1700	1520	800

[a] Production figures are not actual production but represent maximum capacity after allowing for normal conservation measures and a moderate discovery rate. Similarly, export figures represent maximum export volumes or export potential at full capacity production. Actual production and exports are likely to be more variable but must always be less than capacity.

Sources: OPEC (1967-73), OECD (1975, 1973), MIT Energy Laboratory (1974), Middle East Economic Digest (1975), Iskandar (1974), and Sources in Tables 1 and 2.

It appears certain that the energy consumption of OPEC countries will increase until it approaches a figure commensurate with their total wealth level. By the mid-1980's, this consumption will probably be greater than 10 percent of their total production. If this forecast holds, the OPEC countries are likely to become more conservation conscious and begin to withhold oil for their own future use. Thus, the future oil exports of OPEC could turn out to be well below what one would forecast on the basis of either non-OPEC world demand or OPEC capacity.

THE GLOBAL OIL BALANCE

This section summarizes the information used by CACI to represent world energy balance by region. Estimates are then derived for the net global balance of non-OPEC countries.

Table 11 summarizes the estimates selected by CACI to represent the oil balance of Communist countries. Total oil imports of East Europe and the Soviet Union are forecast to exceed total oil exports by 1980. The Communist countries as a group, however, should regain their present level of net oil exports by 1985 as Chinese oil production gains momentum.

Table 12 summarizes Tables 5 through 9 and presents a global forecast by focusing on four regions: Communist countries, OECD, LDC's, and OPEC. The bottom row in Table 12 represents the net global demand for OPEC oil. In general, this figure should be equal to total oil exports of OPEC. For this report we have assumed that this balance will hold during the 1975 to 1985 period. That is, the demand for OPEC oil will not exceed the available supply. While this assumption is reasonable, it is possible that, for a variety of reasons (including conservation and low absorptive capacity), some countries will cut production so that total OPEC exports would be significantly below the world demand.

TABLE 11

Oil Imports of Communist Countries
(mil. metric tons)

	1965	1970	1975	1980	1985
East European Imports	21	37	64	92	125
Soviet Imports	-75	-112	-144	-80	- 80
COMECON Imports	-54	- 95	- 80	12	45
Chinese Imports	- 0	- 03	- 10	-40	-150
Other Communist Countries	05	07	09	18	20
Net Imports of All Communist Countries	-49	- 91	- 81	-10	- 85

Sources: Based on Tables 6, 7, and 8.

TABLE 12

World Oil Balance by Region
(mil. metric tons)

	1965	1970	1975	1980	1985
Communist Balance	049	091	0081	0010	0085
OECD Balance	-490	-877	-1200	-1400	-1670
LDC's Balance	-055	-100	-0165	-0150	-0005
Non-OPEC Balance	-496	-886	-1284	-1540	-1590
OPEC Consumption	-024	-035	- 050	- 100	- 220
Non-OPEC World Energy Deficit = Total Demand for OPEC Oil[a]:	-520	-921	-1334	-1640	-1810

[a] Demand for OPEC oil is equivalent to the sum of all regional balances of energy plus OPEC's own consumption.

Sources: Based on Tables 1 through 11.

SUMMARY

This appendix has presented forecasts of energy demand from OPEC countries over the next 10 years by major world regions. Existing forecasts were reviewed against the background of recent developments that might modify the initial estimates.

The highly speculative nature of forecasts of world demand for OPEC oil has been stressed throughout the paper. Changing rates of industrialization in OPEC countries, rates of economic growth in non-OPEC and OPEC countries, political decisions by the Soviet Union, and the potential for additional oil discoveries are only a few of the unknowns that could effect on the forecasts. Nevertheless, the following occurrences are anticipated:

- Oil consumption by OECD countries will double by 1985, while domestic oil production will increase by almost two and one-half times the 1970 level.
- The Soviet Union may become a net oil importer by 1985 as exports to Eastern European countries are cut back.
- China will have the capacity to be an important oil supplier by 1985.
- Domestic demands for oil in the OPEC countries will increase dramatically by 1985 as economic growth surges in these states. This may produce an intensified interest in oil conservation by selected OPEC states.

APPENDIX B

Estimation and Forecasts of Oil Revenues of Individual Organization of Petroleum Exporting Countries (1970-1985)

INTRODUCTION

Appendix B attempts to estimate annual oil production and oil revenues from 1970-1985 for each member of the Organization of Petroleum Exporting Countries (OPEC). Existing estimates and/or actual data from 1970 onward have been utilized to develop these forecasts. Available information often had sizable gaps; therefore, considerable weight was given to expert judgment.

Since this appendix examines the capabilities and likely behavior of the OPEC countries, we have considered both what the country can do (that is, its capacity) and what it is likely to do given its membership in OPEC. Hence, an attempt has been made to draw on two different perspectives. First, we have treated OPEC as a group to analyze behavioral characteristics of the organization. For instance, it might be useful to study the potential bargaining capability of OPEC vis-a-vis the major consuming countries[1] by considering OPEC states as a group. Second, we have focused on aspects of the behavior of individual OPEC countries.

The forecasting methodology used to estimate total petroleum production, domestic oil consumption, oil exports, production capacity, and oil reserves drew on certain assumptions about each of these areas. These assumptions are elaborated in the next section. The final section briefly reviews the procedures used to generate the estimates and then presents the estimates themselves.

[1] See Appendix A for the treatment of demand for OPEC oil as an example of the treatment of OPEC as a group.

SOME ASSUMPTIONS USED TO GUIDE THE FORECASTS

Information and assumptions in six areas -- known oil reserves, production capacity, current production, domestic oil consumption, petroleum exports, and revenues from petroleum -- were used to guide the forecasts.

OIL RESERVES

Estimates of proven, probable, and potential reserves of each country were used to project present reserves. Then, on the basis of probable and potential reserves and annual production, net increases in the proven reserves were estimated. In countries such as Libya, where exploration activities have been reduced and discovery of new reserves is not seen as urgent for maintaining governmental expenditures, it was assumed that the rate of discovery would be significantly less than the historical trend.

PRODUCTION CAPACITY

It was assumed that production capacity would be increased only in countries where the life of the proven reserves was likely to exceed 15 years at current production levels. Furthermore, it was assumed that in countries where production rates were cut back as a result of governmental policy (such as Venezuela, Kuwait, and Libya), production capacity would decline after a delay of 2 to 5 years. Where the oil industry equipment is older and reserves are near exhaustion, the lag would be about 2 years. In cases such as Kuwait, where reserves are substantial and most installations are in good condition, the lag would be longer.

After considering reserves, the rate of increase of production capacity was assumed to be related primarily to governmental need for additional revenues, existing plans for expanding the oil industry, and forecasts of future world demand for OPEC petroleum.

CURRENT PRODUCTION

Production was assumed to be most directly related to governmental plans and revenue needs, and the production capacity of each country's oil industry. It was assumed that a slight world oversupply of petroleum during the next few years would continue, but that after 1977 most countries would behave as though they could sell as much oil as they were willing to provide. In some cases, however, the production estimates are at variance with previous long-range plans. This is largely due to the fact that most of these plans were made prior to October 1973 and did not consider the increases in oil prices that have occurred since then. Prior to October 1973, for instance, Saudi Arabia was projecting oil production figures for the 1980's in the range of 18 to 20 million barrels per day. As a result of the oil price increases, it seems unlikely that the Saudi Government would allow its production capacity to reach that level.[2] In cases where OPEC members have devised post-1973 production programs that take reassessed revenue needs into account in light of new oil prices, these programs were used as the basis for the forecasts (for example, Venezuela, Kuwait, and Qatar).

DOMESTIC OIL CONSUMPTION

The domestic consumption of petroleum in the OPEC countries has been increasing at a very fast pace. The rate of increase in countries such as Saudi Arabia, the United Arab Emirates, and Iran has been as high as 16 to 20 percent in some years. Prior to October 1973, the Iranian Government had projected an annual growth rate of about 11 percent for Iranian domestic oil consumption for the 1975-85 period. This figure should

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[2] At present, oil prices at this production rate would result in $80 billion revenue. This would create major absorptive problems for the small population and limited administrative capabilities for Saudi Arabia. It is also unlikely that Saudi Arabia would feel such a large amount of money would be safe as deposits in foreign banks or investments in the industrial countries.

increase by at least 3 to 5 percent to account for the new growth targets of the Iranian planners and the recent performance of the Iranian economy. In estimating the future consumption of petroleum, all current development plans of OPEC countries were examined and their projected growth rates considered. On the basis of these and other forecasts of gross domestic product (GDP), the petroleum consumption of OPEC was projected using an income elasticity of demand for petroleum that was generally between 1.0 and 1.2. In general, this resulted in very high growth rates in energy consumption, but these projections were relatively moderate in comparison with growth rates of Japanese energy consumption during the 1960's.

PETROLEUM EXPORTS

The petroleum exports of each OPEC member are assumed to be approximately equal to the country's production minus domestic consumption of petroleum. In some cases, this figure may not be equal to actual exports because of bookkeeping problems or changes of stocks.

REVENUES FROM PETROLEUM

Total oil revenues for the 1975-85 period were calculated by the simple multiplication of annual oil exports by the base price per barrel of petroleum for each country. These base prices are listed in Table 1. Generally, these figures assumed a base price of $10 per barrel for Arabian light, the industry standard. All other variations are assumed to be largely due to mixture, sulphur content, and transportation premiums. It was assumed that oil prices would remain constant in real terms during the 1975-85 period. Therefore, for the 1975-85 period oil revenues are essentially the same as the value of oil exports. However, this is not the case for the years prior to 1975. For these years oil prices and government per-barrel revenues differed by as much as 40 percent with the difference going to the concessionary oil companies. Therefore, actual governmental revenue for the years prior to 1975 was used rather than the value of oil exports.

TABLE 1

Base Prices for OPEC Oil by Country
(per barrel)

Algeria	U.S. $11.50
Ecuador	11.50
Gabon	11.50
Indonesia	11.00
Iran	10.00
Iraq	10.00
Kuwait	10.00
Libya	11.50
Nigeria	11.50
Qatar	10.00
Saudi Arabia	10.00
United Arab Emirates	11.00
Venezuela	11.50

THE FORECASTING METHODOLOGY

The methodology involved in the forecasts was relatively simple. First, the best estimates available for six kinds of information -- oil reserves, production capacity, current production, domestic consumption, petroleum exports, and petroleum revenues -- were gathered. Second, after the information was checked for reliability and consistency, annual projections for each variable for each country were made for 5-year time periods. After 5-year projections for each variable were computed, consistency was checked across the variables. Then, once required adjustments were made, the next 5 years were forecast, checked for consistency, and (if need be) adjusted. Projections were undertaken for each of the 13 countries on a country-by-country basis. Because of uncertainties about reserve levels, these forecasts must be used with caution.

A GUIDE TO THE RESULTS

Tables 2-14 present forecasts of production, consumption, exports, production capacity, and petroleum reserves on a country-by-country basis. Table 15 presents forecasts of the oil revenues for each country. The revenue figures are presented in alphabetical order, corresponding to the order of country chapters presented earlier in this report.

The following conventions are used throughout the tables:

A = actual data
E = estimated data
P = projected estimate

In general, "A" refers to statistics for which more or less complete information was available, though some adjustments may have been made to get a continuous time series. "E" refers to situations in which only incomplete information was available. "P" refers to forecasts made according to the procedures described in this section.

TABLE 2

Projections for the Algerian Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	1.029 A	0.039 A	0.974 A	1.150	8.0
1971	0.785 A	0.041 A	0.702 A	1.150	7.6
1972	1.062 A	0.047 A	0.997 A	1.100	7.3
1973	1.075 A	0.055 A	1.020 E	1.100	7.6
1974	0.945 A	0.044 A	0.897 E	1.100	7.3
1975	0.950 E	0.066 E	0.885 E	1.100	7.0
1976	0.950 P	0.070 P	0.880 P	1.100	6.7
1977	0.950 P	0.076 P	0.870 P	1.100	6.4
1978	0.950 P	0.079 P	0.865 P	1.100	6.1
1979	0.950 P	0.086 P	0.860 P	1.050	5.8
1980	0.950 P	0.092 P	0.850 P	1.050	5.5
1981	0.900 P	0.099 P	0.800 P	1.050	5.2
1982	0.900 P	0.110 P	0.780 P	1.000	4.9
1983	0.900 P	0.117 P	0.775 P	1.000	4.6
1984	0.900 P	0.127 P	0.760 P	1.000	4.3
1985	0.900 P	0.139 P	0.755 P	1.000	4.0

TABLE 3

Projections for the Ecuadorean Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	0.004 A	0.024 A	-0.019 A	0.008	1.50
1971	0.004 A	0.025 A	-0.023 A	0.200	1.50
1972	0.070 A	0.028 E	0.035 E	0.240	1.47
1973	0.204 A[a]	0.032 E	0.160 E	0.240	1.40
1974	0.160 A[a]	0.037 E	0.120 E	0.240	1.33
1975	0.200 E[a]	0.043 E	0.155 E	0.240	1.28
1976	0.240 P[a]	0.050 P	0.190 P	0.300	1.20
1977	0.280 P[a]	0.057 P	0.220 P	0.350	1.30
1978	0.300 P[a]	0.065 P	0.235 P	0.400	1.50
1979	0.400 P[a]	0.072 P	0.325 P	0.500	2.00
1980	0.500 P[a]	0.089 P	0.420 P	0.550	2.60
1981	0.550 P	0.099 P	0.460 P	0.600	3.00
1982	0.600 P	0.115 P	0.500 P	0.650	2.90
1983	0.600 P	0.115 P	0.480 P	0.650	2.80
1984	0.600 P	0.129 P	0.470 P	0.650	2.70
1985	0.600 P	0.142 P	0.456 P	0.610	2.50

[a] Ecuador's production plan for 1972-1980 was as follows: .200 (1972), .250 (1973-74), .300 (1975), .400 (1976-78), .500 (1979), and .600 (1980).

TABLE 4

Projections for the Gabon Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	0.109 A	0.0030 E	0.105 E	0.130	1.17
1971	0.115 A	0.0032 E	0.113 E	0.150	1.18
1972	0.152 E	0.0040 E	0.147 E	0.180	1.17
1973	0.147 A	0.0048 E	0.141 E	0.185	1.15
1974	0.180 A	0.0059 E	0.174 E	0.220	1.17
1975	0.210 E	0.0069 E	0.202 E	0.250	1.10
1976	0.221 P	0.0084 P	0.213 P	0.275	1.04
1977	0.220 P	0.0100 P	0.210 P	0.280	0.97
1978	0.220 P	0.0115 P	0.208 P	0.280	1.50
1979	0.220 P	0.0128 P	0.206 P	0.280	2.00
1980	0.220 P	0.0140 P	0.203 P	0.280	2.00
1981	0.230 P	0.0155 P	0.212 P	0.300	1.95
1982	0.250 P	0.0170 P	0.231 P	0.300	1.90
1983	0.255 P	0.0190 P	0.230 P	0.300	1.81
1984	0.260 P	0.0240 P	0.235 P	0.300	1.71
1985	0.270 P	0.0320 P	0.238 P	0.300	1.61

TABLE 5

Projections for the Indonesian Oil Industry

	Production mil. bbl/d	Consumption mil. bbl/d	Exports mil. bbl/d	Capacity mil. bbl/d	Reserves bil. bbl's
1970 A	0.854	0.109	0.725	0.900	9.0
1971 A	0.892	0.125	0.749	0.950	10.0
1972 A	1.079	0.138	0.941	1.150	10.3
1973 A	1.339	0.152	1.100	1.400	10.5
1974 A	1.380	0.167	1.164	1.500	11.1
1975 E	1.280	0.185	1.095	1.700	11.7
1976 P	1.500[a]	0.205	1.216[a]	1.800	12.4
1977 P	1.700[a]	0.228	1.408[a]	1.950	13.0
1978 P	1.810[a]	0.253	1.507[a]	2.050	13.5
1979 P	1.970[a]	0.280	1.671[a]	2.150	14.1
1980 P	2.150	0.311	1.800	2.300	14.7
1981 P	2.350	0.340	1.950	2.450	15.4
1982 P	2.500	0.372	2.080	2.580	16.2
1983 P	2.700	0.409	2.250	2.750	17.1
1984 P	2.850	0.450	2.400	2.900	17.8
1985 P	3.000	0.500	2.450	3.012	18.3

[a] Under Repelita II's production plan.

TABLE 6

Projections for the Iranian Oil Industry

	Production mil. bbl/d	Consumption mil. bbl/d	Exports mil. bbl/d	Capacity mil. bbl/d	Reserves bil. bbl's
1970	3.829 A	0.182 A	3.626 A	4.300	63.0
1971	4.539 A	0.195 A	3.429 A	5.000	62.5
1972	5.023 A	0.219 A	4.805 A	5.800	61.5
1973	5.861 A	0.284 A	5.577 A	6.000	60.0
1974	6.131 A	0.355 E	5.796 E	6.300	61.0
1975	5.550 E	0.409 E	5.040 E	6.500	61.5
1976	6.500 P	0.510 P	5.990 P	6.900	62.0
1977	7.300 P[a]	0.600 P[a]	6.700 P[a]	7.200	63.5
1978	7.370 P[b]	0.690 P	6.680 P	7.550	64.5
1979	7.600 P[b]	0.770 P	6.830 P	7.800	61.8
1980	7.614 P[b]	0.862 P	6.752 P	8.000	59.0
1981	7.600 P[b]	0.965 P	6.635 P	7.950	57.5
1982	7.600 P[b]	1.100 P	6.500 P	7.900	55.7
1983	7.600 P[b]	1.232 P	6.368 P	7.850	52.9
1984	7.613 P[b]	1.367 P	6.240 P	7.800	51.2

[a] According to Fifth Revised Plan, production in 1977 shall be 7.3 and exports 6.7 while consumption 0.6 millions of barrels per day.

[b] National Iranian Oil Company (NIOC) plan based on no major increases in reserves.

TABLE 7

Projections for the Iraqi Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	1.549 A	0.062 A	1.496 A	1.850	30.0
1971	1.694 A	0.070 A	1.619 A	1.900	30.0
1972	1.465 A	0.076 A	1.436 A	2.000	30.0
1973	1.964 A	0.089 E	1.865 E	2.200	31.5
1974	1.820 A	0.104 E	1.700 E	2.400	33.0
1975	2.250 E	0.123 E	2.100 E	2.600	35.0
1976	2.450 P	0.148 P	2.300 P	2.700	40.0
1977	2.600 P	0.166 P	2.430 P	2.850	45.0
1978	2.800 P	0.187 P	2.600 P	3.000	48.0
1979	3.000 P	0.209 P	2.780 P	3.150	50.0
1980	3.200 P	0.235 P	2.950 P	3.350	52.0
1981	3.400 P	0.260 P	3.130 P	3.600	53.0
1982	3.600 P	0.286 P	3.304 P	3.800	54.0
1983	3.800 P	0.312 P	3.480 P	4.000	56.0
1984	4.000 P	0.343 P	3.650 P	4.150	58.0
1985	4.200 P	0.372 P	3.820 P	4.300	60.0

TABLE 8

Projections for the Kuwaiti Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	3.160 A	0.014 A	3.133 A	3.200	67.7
1971	3.374 A	0.016 A	3.319 A	3.400	66.5
1972	3.488 A	0.017 A	3.654 A	3.500	65.3
1973	3.218 A	0.020 A	3.154 E	3.500	64.0
1974	2.734 A	0.025 A	2.654 E	3.500	63.0
1975	2.200 E	0.030 E	2.150 E	3.500	62.2
1976	2.200 P	0.035 P	2.150 P	3.400	61.4
1977	2.100 P	0.041 P	2.050 P	3.300	60.6
1978	2.100 P	0.048 P	2.050 P	3.200	59.9
1979	2.000 P	0.054 P	1.930 P	3.100	59.2
1980	2.000 P	0.061 P	1.920 P	2.900	58.5
1981	2.000 P	0.068 P	1.910 P	2.700	57.8
1982	2.000 P	0.078 P	1.905 P	2.500	56.0
1983	2.000 P	0.086 P	1.900 P	2.400	55.3
1984	2.000 P	0.095 P	1.900 P	2.300	54.6
1985	2.000 P	0.105 P	1.890 P	2.200	53.8

TABLE 9

Projections for the Libyan Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	3.318 A	0.016 A	3.312 A	3.500	29.0
1971	2.761 A	0.020 A	2.747 A	3.550	27.9
1972	2.239 A	0.024 A	2.214 A	3.500	26.1
1973	2.187 A	0.029 E	2.155 E	3.400	25.5
1974	1.520 A	0.035 E	1.480 E	3.200	24.7
1975	1.750 E	0.042 E	1.700 E	3.000	24.1
1976	2.000 P	0.048 P	1.945 P	2.800	23.4
1977	2.150 P	0.059 P	2.090 P	2.600	22.6
1978	2.200 P	0.066 P	2.130 P	2.500	21.8
1979	2.250 P	0.075 P	2.170 P	2.450	21.0
1980	2.300 P	0.083 P	2.210 P	2.450	20.2
1981	2.350 P	0.092 P	2.250 P	2.450	19.3
1982	2.400 P	0.103 P	2.390 P	2.500	18.4
1983	2.450 P	0.144 P	2.330 P	2.500	17.4
1984	2.450 P	0.126 P	2.320 P	2.550	16.5
1985	2.450 P	0.139 P	2.310 P	2.600	15.7

TABLE 10

Projections for the Nigerian Oil Industry

	Production mil. bbl/d	Consumption mil. bbl/d	Exports mil. bbl/d	Capacity mil. bbl/d	Reserves bil. bbl's
1970	1.084 A	0.028 A	1.051 A	1.400	20.5
1971	1.559 A	0.034 A	1.486 A	1.800	20.0
1972	1.822 A	0.040 A	1.756 A	2.100	20.5
1973	2.054 A	0.049 E	2.000 E	2.200	20.0
1974	2.260 A	0.070 E	2.185 E	2.300	19.3
1975	1.840 E	0.090 E	1.745 E	2.500	18.5
1976	2.000 P	0.115 P	1.880 P	2.550	17.9
1977	2.300 P	0.133 P	2.160 P	2.600	17.2
1978	2.400 P	0.149 P	2.247 P	2.650	16.6
1979	2.450 P	0.165 P	2.281 P	2.650	16.0
1980	2.500 P	0.173 P	2.320 P	2.650	15.0
1981	2.600 P	0.191 P	2.402 P	2.700	14.0
1982	2.700 P	0.209 P	2.488 P	2.900	13.0
1983	2.800 P	0.236 P	2.560 P	3.000	12.0
1984	2.900 P	0.265 P	2.630 P	3.100	11.0
1985	3.000 P	0.300 P	2.700 P	3.150	10.0

TABLE 11

Projections for the Qatar Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	0.362 A	0.0016 A	0.363 A	0.450	7.0
1971	0.431 A	0.0017 A	0.429 A	0.500	6.9
1972	0.482 A	0.0020 A	0.482 A	0.550	6.7
1973	0.570 A	0.0022 E	0.567 E	0.600	6.5
1974	0.520 A	0.0025 E	0.517 E	0.620	6.3
1975	0.470 E	0.0029 E	0.467 E	0.700	6.1
1976	0.550 P	0.0034 P	0.546 P	0.700	6.0
1977	0.600 P	0.0039 P	0.596 P	0.700	5.8
1978	0.600 P	0.0045 P	0.595 P	0.700	5.6
1979	0.550 P	0.0052 P	0.544 P	0.700	5.4
1980	0.550 P	0.0060 P	0.544 P	0.650	5.2
1981	0.550 P	0.0068 P	0.543 P	0.650	5.0
1982	0.500 P	0.0077 P	0.492 P	0.650	4.8
1983	0.500 P	0.0087 P	0.491 P	0.600	4.6
1984	0.500 P	0.0098 P	0.490 P	0.600	4.4
1985	0.500 P	0.0112 P	0.488 P	0.600	4.2

TABLE 12

Projections for the Saudi Arabian Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	3.799 A	0.042 A	3.783 A	4.000	86.0
1971	4.769 A	0.047 A	4.716 A	5.100	91.0
1972	6.012 A	0.052 A	6.012 A	6.150	92.0
1973	7.610 A	0.060 E	7.550 E	7.800	97.0
1974	8.490 A	0.080 E	8.400 E	10.000	
1975	7.200 E	0.100 E	7.100 E	11.500	110.0
1976	8.500 P	0.125 P	8.350 P	11.700	120.0
1977	9.500 P	0.147 P	9.350 P	11.900	117.0
1978	11.000 P	0.170 P	10.800 P	12.100	113.5
1979	12.000 P	0.200 P	11.800 P	12.300	110.3
1980	12.500 P	0.225 P	12.255 P	13.500	106.0
1981	13.000 P	0.250 P	12.745 P	13.700	101.8
1982	13.500 P	0.280 P	13.210 P	13.800	96.5
1983	13.500 P	0.310 P	13.180 P	13.900	92.0
1984	13.500 P	0.345 P	13.145 P	14.000	87.6
1985	13.500 P	0.377 P	13.110 P	14.000	82.5

TABLE 13

Projections for the UAE Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970	0.770 A	0.0030 A	0.770 A	1.000	20.0
1971	1.059 A	0.0035 A	1.053 A	1.200	23.0
1972	1.205 A	0.0043 A	1.205 A	1.500	24.0
1973	1.526 A	0.0055 E	1.516 E	1.700	24.5
1974	1.676 A	0.0070 E	1.667 E	1.800	25.0
1975	1.700 E	0.0100 E	1.690 E	2.400	25.5
1976	1.800 P	0.0120 P	1.790 P	2.500	25.0
1977	2.000 P	0.0138 P	1.990 P	2.600	24.3
1978	2.200 P	0.0156 P	2.180 P	2.700	23.6
1979	2.300 P	0.0180 P	2.280 P	2.750	22.8
1980	2.300 P	0.0210 P	2.280 P	2.800	22.1
1981	2.300 P	0.0228 P	2.280 P	2.800	21.3
1982	2.300 P	0.0242 P	2.280 P	2.800	20.6
1983	2.300 P	0.0270 P	2.270 P	2.750	19.8
1984	2.200 P	0.0300 P	2.170 P	2.700	19.0
1985	2.100 P	0.0330 P	2.063 P	2.500	18.3
1986	2.100 P	0.0365 P	2.064 P	2.300	17.6
1987	2.100 P	0.0400 P	2.060 P	2.300	16.0
1988	2.000 P	0.0445 P	1.955 P	2.300	15.3
1989	2.000 P	0.0500 P	1.950 P	2.300	14.7
1990	2.000 P	0.0550 P	1.945 P	2.200	13.9

TABLE 14

Projections for the Venezuelan Oil Industry

	Production mil. b/d	Consumption mil. b/d	Exports mil. b/d	Capacity mil. b/d	Reserves bil. b's
1970 A	3.708 A	0.148 A	3.465 A	3.800	14.0
1971 A	3.549 A	0.158 A	3.259 A	3.700	13.8
1972 A	3.220 A	0.164 A	3.084 A	3.500	13.9
1973 E	2.805 A	0.180 E	2.610 E	3.350	13.9
1974 E	2.770 A	0.192 E	2.578 E	3.200	12.8
1975 E	2.500 E	0.210 E	2.290 E	3.100	11.9
1976 P	2.681 P	0.220 P	2.461 P	3.000	10.9
1977 P	2.551 P	0.235 P	2.316 P	2.900	10.0
1978 P	2.423 P	0.250 P	2.173 P	2.800	9.1
1979 P	2.300 P	0.259 P	2.041 P	2.600	8.3
1980 P	2.185 P	0.267 P	1.918 P	2.400	7.7
1981 P	2.076 P	0.275 P	1.801 P	2.200	7.0
1982 P	1.972 P	0.282 P	1.690 P	2.100	6.3
1983 P	1.873 P	0.290 P	1.583 P	2.000	5.7
1984 P	1.779 P	0.297 P	1.482 P	1.900	5.1
1985 P	1.690 P	0.306 P	1.384 P	1.800	4.6

TABLE 15

Oil Revenues
(revenue in bil. U.S. $)

	Algeria 11.5 $/bbl's	Ecuador 11.5 $/bbl's	Gabon 11.5 $/bbl's	Indonesia 11.0 $/bbl's	Iran 10.0 $/bbl's	Iraq 10.0 $/bbl's
1970	0.272 A	(0.0)[a]	0.040 E	0.446 A	1.290 A	0.593 A
1971	0.324 A	(0.0)[a]	0.070 E	0.478 A	2.184 A	0.987 A
1972	0.613 A	0.024 E	0.100 E	0.913 A	2.607 A	0.664 A
1973	0.931 E	0.146 E	0.134 E	1.599 E	5.153 A	1.825 A
1974	3.274 E	0.394 E	0.572 E	4.673 E	20.399 E	5.154 E
1975	3.715 E	0.651 E	0.848 E	4.396 E	18.396 E	7.665 E
1976	3.694 P	0.797 P	0.894 P	4.882 P	21.863 P	8.395 P
1977	3.652 P	0.923 P	0.881 P	5.653 P	24.455 P	8.869 P
1978	3.631 P	0.986 P	0.873 P	6.051 P	24.382 P	9.490 P
1979	3.610 P	1.364 P	0.865 P	6.709 P	24.929 P	10.147 P
1980	3.568 P	1.762 P	0.852 P	7.226 P	24.645 P	10.767 P
1981	3.358 P	1.931 P	0.890 P	7.829 P	24.217 P	11.424 P
1982	3.274 P	2.099 P	0.970 P	8.351 P	23.725 P	12.060 P
1983	3.253 P	2.015 P	0.965 P	9.034 P	23.243 P	12.702 P
1984	3.190 P	1.973 P	0.986 P	9.636 P	22.776 P	13.322 P
1985	3.169 P	1.914 P	0.999 P	9.836 P	17.848 P	13.943 P

[a] Excluding concession payments.

TABLE 15 (Cont'd)

Oil Revenues
(revenue in bil. U.S. $)

	Kuwait 10.0 $/bbl's	Libya 10.0 $/bbl's	Nigeria 11.5 $/bbl's	Qatar 10.0 $/bbl's	Saudi Arabia 10.0 $/bbl's	UAE 11.0 $/bbl's	Venezuela 11.5 $/bbl's
1970	1.085 A	1.585 A	0.219 A	0.122 A	1.214 A	0.241 A	1.409 A
1971	1.692 A	2.204 A	0.973 E	0.197 A	1.885 A	0.462 A	1.755 A
1972	1.797 A	2.205 A	1.113 E	0.245 A	2.745 A	0.605 A	1.956 A
1973	1.950 A	2.041 E[b]	3.420 E	0.388 A	4.340 A	0.898 A	2.955 A
1974	8.046 E	5.000 E	7.975 E	1.415 E	22.573 A	4.215 E	8.469 E
1975	9.024 E	7.446 E	7.325 E	1.704 E	26.280 E	6.785 E	9.612 E
1976	9.025 P	8.235 P	7.891 P	1.992 P	31.025 P	7.628 P	10.330 P
1977	8.604 P	8.772 P	9.067 P	2.175 P	34.675 P	7.990 P	9.721
1978	8.604 P	8.941 P	9.432 P	2.172 P	40.150 P	8.753 P	9.121 P
1979	8.101 P	9.108 P	9.574 P	1.986 P	43.800 P	9.154 P	8.567 P
1980	8.059 P	9.276 P	9.738 P	1.986 P	45.625 P	9.154 P	8.051 P
1981	8.017 P	9.444 P	10.082 P	1.982 P	47.450 P	9.154 P	7.560 P
1982	7.996 P	10.032 P	10.443 P	1.796 P	49.275 P	9.154 P	7.094 P
1983	7.975 P	9.780 P	10.746 P	1.792 P	49.275 P	9.114 P	6.645 P
1984	7.975 P	9.738 P	11.039 P	1.788 P	49.275 P	8.712 P	6.221 P
1985	7.933 P	9.696 P	11.333	1.781 P	49.275 P	8.283 P	5.809 P

[b] 1973 for Libya was a 9-month transitional fiscal year. The data were adjusted to a 12-month equivalent.

APPENDIX C

Regression Equations

INTRODUCTION

The regression equations used to forecast the performance of individual sectors of the economies of Organization of Petroleum Exporting Countries (OPEC) members are presented in this appendix. The equations and related statistics are presented after a summary discussion of regression procedures.

REGRESSION PROCEDURES

Regression equations fitted to historical data are the basic means of forecasting the performance of the OPEC economies. In selecting particular equations, three criteria must be observed. First, the equation must provide a reasonable fit on historical data to be able to employ the coefficient for forecasting. Second, the equation should, ideally, be capable of registering the effects of government spending to promote development. Finally, the equations for a country, taken together, should constitute a set that can describe overall economic activity under a variety of government spending programs and spending levels. Given these criteria, classes of equations can be considered as more or less appropriate for types of sectors across countries and particular sectors within countries.

In general, the preferred form for any equation is a specification employing a "previously" determined independent variable. Recall from Chapter 2 the discussion of "consistency calculations" required to insure that output estimates and national accounts estimates be in agreement. All "previously determined" variables are those not altered by the consistency calculations. Included in this group are all lagged variables, the independently projected petroleum revenue and petroleum exports variables, and any individual component or subaggregate of government spending. In effect, this set of variables exhausts the list that is "exogenous" to the current year's forecast.

On different criteria, the same set of variables is the preferred set of independent variables. The specification of lagged variables, particularly lagged capital formation and government development spending, as independent variables is consistent with a time lag between outlays for capital accumulation and realization of output. Contemporaneous values of government spending are appropriate for sectors more responsive in time to given outlays; an obvious example is the government services sector. An approximate ordering of different equation specifications is as follows (exceptions are noted below): (1) lagged government development spending by sector; (2) lagged capital formation by sector; (3) unlagged government spending, current budget, and development budget by sector; (4) unlagged capital spending by sector; (5) classes and subaggregates of government spending; (6) total government spending; (7) lagged output of the sector; and (8) contemporaneous values of national accounts variables except imports. This sequence is approximate and varied according to available, reliable data for each country and the judgments of the research staff given their understanding of the economy. Generally, best fit criteria, measured by (unadjusted) R^2, were used to distinguish among equations if no clear substantive preference could be established.

The most tempting equation explains each sector's output by government spending devoted toward promoting that sector. A successful equation of this class would easily register the effects of governmental activities. Unfortunately, several problems are associated with "running" a sector in this manner. First, the historical performance of most of the OPEC economies generates regression coefficients that are either extremely large or extremely small. In the former case, non-government activity is improperly associated with government spending, creating an overestimate of government prowess and effectiveness. The sector would then explode as oil revenues expand the scale of spending programs. In the second case, it is generally true that government spending displays historical fluctuations making it impossible to capture any possible effects on the sector's output. However, there are sectors for which government spending does provide an historical fit that can be expected to hold in

the future. Selected sectors in several countries are explained in this way, and the public services sector of every country is explained entirely by government spending.

The most straightforward equation for every country is the petroleum sector. With the exception of Qatar and the United Arab Emirates, the petroleum sector is explained by petroleum exports. These equations perform well and provide acceptable forecasts for the oil industry. The only possible exceptions are Iran (in the period 1982 -1985) and Iraq (during the same years). In these cases, domestic consumption should increase as exports decline relatively more quickly than production. Despite this known projection, the unknown, internal pricing policies for petroleum make it difficult to run the oil sector on production forecasts. Consequently, exports were employed as the independent variable throughout the period.

Lagged output regressions fit historical records for every non-petroleum sector better than any other form. Selecting this form effectively establishes the sector's performance throughout the forecast, regardless of governmental activity and the remainder of the economy. Equations of this class are used for particular sectors in several countries. When a lagged output equation was selected, it was chosen because the research staff believed it would more accurately describe the sector's performance than other candidates.

Because the project has concentrated on absorptive capacity (implying constraints), very few sectors depend on demand conditions. Typically, the commerce sector of every country depends on total consumption spending. The staff's judgment that wholesale and retail trade would respond to demand and not be constrained by previous capital formation in the sector is the reason for this specification. The same reason underlies the explanation of the miscellaneous personal services sector by consumption expenditures. Construction in most countries is also a demand-responsive sector, the demand being either gross fixed capital formation, government spending for public works, or total

government development spending. Within these general classes, the particular equations for each sector vary from country to country. The exact independent variable is listed in the table of equations for each country.

ESTIMATION

All regression equations were estimated by ordinary least squares (OLS). More elaborate single equation techniques were not employed because the accuracy of reported data was judged insufficient to warrant their use. Multiple equation estimation was not used for two reasons. First, the length of the most reliable segments of the data was relatively short, in some cases sufficiently short to rule out multiple equation estimation directly. Second, the most compelling reason for multiple equation estimation would be the ability to estimate output equations subject to constraints from availability of factors of production. Again, the availability of reliable data ruled out this possibility.

The inability to employ constrained regression techniques has produced a characteristic of the forecast model that requires comment. Most of the OPEC economies have historically experienced labor shortages. By using OLS on the form of the equations without constraints, unbiased estimators of the coefficients are generated. However, the OLS estimators are probably not unbiased estimators of the "true" coefficients in a correctly specified, multiple equation system. Consequently, attempts to generate maximum growth forecasts have an implied, unknown constraint even though the economy was not subjected to an explicit labor constraint for the particular forecast simulation. The research staff explained the pattern that emerged in the forecasts for several countries to be a result of this constraint. The unconstrained forecast (and at times forecasts with relatively liberal immigration policies) showed a substantial rise in gross domestic product (GDP) followed by an equally dramatic reduction in the rate of increase in GDP. The import pattern accompanying the GDP path is a parallel rise in imports followed by a period of no

import increase. Any subsequent import changes are often minor increases after several years, or another discontinuous increase followed by a period of imports held at the new, higher level. The interpretation of this import pattern is that the performance of the economy justifies the initial import rise but does not warrant subsequent increases. Had the data to support constrained regression systems been available, it is the staff's judgment that the import pattern would be more smoothed but, nonetheless, would approximate the reported figures.

COUNTRY EQUATIONS

The regression equations and associated statistics are presented in Tables 1 through 13. The interested reader should refer to the chapter specific to the particular country to judge the relative importance of different sectors to each country.

Tables 10 and 12 do not contain any statistics and are entitled "forecasting equations" rather than regressions. Both Qatar and the United Arab Emirates do not yet report economic activity or economic activity by sector in the usual manner. To forecast these two countries, the staff collected labor force information for both countries, assumed that the countries resemble the economy of Kuwait in 1965, and computed sector GDP data by using 1965 output-labor ratios from Kuwait. Aggregate regressions were run for Kuwait to employ the coefficients for Qatar and the United Arab Emirates. The constant terms were adjusted on the basis of the constructed GDP by sector data and known government spending patterns in the two countries. The results of this exercise are presented in Tables 10 and 12. The Kuwait regressions that established the coefficients are reported in Table 14.

The number of observations for each equation is reported with the equation in the tables. Below each table, the time period is stated for which reliable data were collected for the set of dependent variables. (These data were believed to be accurate and consistent with other variables in the country data set.) Equations employing fewer observations than the number available for the dependent variable were restricted by the time series available for the independent variables (usually requiring earlier observations to be dropped). In selected instances, preliminary figures covering more recent years (generally one at most) were incorporated for some sectors even though the complete and disaggregated data were not available for all sectors.

TABLE 1

Regression Equations for Algeria [a]

AGRICUL	=	1444.62 + 7.993X (2.514)	F = 10.105 R^2 = 0.591 X = lagged output	N = 12
PETROLM	=	1263.41 + 0.690X (0.059)	F = 135.447 R^2 = 0.938 X = petroleum exports	N = 10
INDUSTRY	=	1967.958 + 0.361X (0.050)	F = 52.193 R^2 = 0.963 X = capital formation in industry	N = 9
CONSTRUCT	=	188.773 + 2.310X (0.073)	F = 1002.221 R^2 = 0.990 X = capital formation in construction	N = 11
TRANSPRT	=	-43.935 + 1.192X (0.090)	F = 176.086 R^2 = 0.951 X = lagged output	N = 11
COMMERCE	=	-306.436 + 0.323X (0.013)	F = 605.381 R^2 = 0.989 X = total consumption	N =11
SERVICES	=	279.026 + 0.131X (0.015)	F = 74.021 R^2 = 0.914 X = total consumption	N = 11
PUB-SERV	=	1587.734 + 0.317X (0.019)	F = 266.438 R^2 = 0.985 X = total government spending	N = 11

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1962-1974.

TABLE 2

Regression Equations for Ecuador[a]

AGRICUL	=	$-185.04 + 1.082X$ (0.168)	$F = 41.421$ $R^2 = 0.932$	$N = 10$
			X = lagged output	
PETROLM	=	$449.541 + 0.642X$ (0.010)	$F = 4273.0$ $R^2 = 0.999$	$N = 6$
			X = petroleum exports	
INDUSTRY	=	$1903.57 + 0.566X$ (0.111)	$F = 26.138$ $R^2 = 0.897$	$N = 9$
			X = total fixed capital formation	
UTILITY	=	$177.245 + 0.021X_1$ (0.003) $+ 0.017X_2$ (0.003)	$F = 26.478$ $R^2 = 0.996$	$N = 9$
			X_1 = total fixed capital formation X_2 = lagged X_1	
CONSTRCT	=	$643.403 + 0.183X$ (0.012)	$F = 251.823$ $R^2 = 0.984$	$N = 9$
			X = total fixed capital formation	
TRANSPRT	=	$452.772 + 3.272X$ (0.433)	$F = 57.162$ $R^2 = 0.950$	$N = 9$
			X = lagged, government development spending for transportation	
COMMERCE	=	$-784.127 + 0.169X$ (0.009)	$F = 347.665$ $R^2 = 0.989$	$N = 9$
			X = total consumption	
SERVICES	=	$-1109.393 + 0.142X$ (0.013)	$F = 112.603$ $R^2 = 0.966$	$N = 9$
			X = total consumption	
PUB-SERV	=	$684.140 + 1.218X$ (0.050)	$F = 597.541$ $R^2 = 0.997$	$N = 9$
			X = total current government spending	

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1965-1974.

TABLE 3

Regression Equations for Gabon[a]

AGRICUL	=	535.003 - 0.268X (0.054)	F = 24.551 R^2 = 0.754 X = time	N = 10
Following 1977, equation became, by assumption:				
	=	0.0 + 1.04X, where X = lagged output		
PETROLM	=	4.753 + 1.374X (0.090)	F = 232.623 R^2 = 0.967 X = petroleum exports	N = 10
FORESTRY	=	-1357.682 + 0.693X (0.064)	F = 116.750 R^2 = 0.959 X = time	N = 10
Following 1978, equation became, by assumption:				
	=	0.0 + 1.10X, where X = lagged output		
INDUSTRY	=	0.513 + 0.189X (0.026)	F = 55.018 R^2 = 0.887 X = total gross fixed capital formation	N = 8
CONSTRCT	=	2.573 + 0.074X (0.019)	F = 14.691 R^2 = 0.936 X = total gross fixed capital formation	N = 8
TRANSPRT	=	2.081 + 0.027X (0.003)	F = 65.951 R^2 = 0.917 X = lagged output	N = 8
COMMERCE	=	-5.13 + 0.339X (0.038)	F = 78.411 R^2 = 0.940 X = total consumption	N = 10
MIS-SERV	=	0.0 + 1.045X	Equation forced through the origin, so no statistics appropriate, r = 0.83 X = lagged output	
PUB-SERV	=	0.815 + 0.549X (0.065)	F = 72.534 R^2 = 0.879 X = total, current government spending	N = 12

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1960-1972.

TABLE 4

Regression Equations for Indonesia[a]

AGRICUL	=	280. + 1.046X (0.143)	F = 53.793 N = 10 R^2 = 0.900 X = lagged output
PETROLM	=	37.146 + 0.831X (0.029)	F = 812.132 N = 5 R^2 = 0.996 X = petroleum exports
MANUFACT	=	135.618 + 0.350X (0.042)	F = 68.941 N = 10 R^2 = 0.958 X = total gross fixed capital formation
UTILITY	=	-0.003 + 0.690X (0.059)	F = 134.731 N = 8 R^2 = 0.978 X = government development spending for utility sector
CONSTRCT	=	2.145 + 0.212X (0.004)	F = 2473.762 N = 10 R^2 = 0.997 X = government spending for construction and public works
COMMERCE	=	-256.729 + 0.298X (0.014)	F = 479.420 N = 10 R^2 = 0.992 X = total consumption
TRANSPRT	=	0.032 + 2.815X (0.363)	F = 60.232 N = 10 R^2 = 0.953 X = government development spending for the transportation sector
BANKING	=	0.0149 + 0.084X_1 (0.032) + 0.274X_2 (0.066)	F = 6.646 N = 10 R^2 = 0.994 X_1 = government funds placed into loan granting institutions for the promotion of investment X_2 = lagged X_1
HOUSING	=	7.825 + 0.024X (0.003)	F = 85.799 N = 8 R^2 = 0.935 X = government housing loans and housing construction
SERVICES	=	8.525 + 0.053X (0.002)	F = 736.482 N = 8 R^2 = 0.942 X = total consumption
PUB-SERV	=	11.418 + 0.374X (0.013)	F = 789.813 N = 10 R^2 = 0.990 X = total government spending

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1960-1973.

TABLE 5

Regression Equations for Iran[a]

AGRICUL	=	0.001 + 1.055X (0.070)	F = 224.066 R^2 = 0.974 X = lagged output	N = 14
PETROLM	=	-17.822 + 1.146X (0.056)	F = 413.023 R^2 = 0.986 X = petroleum exports	N = 10
INDUSTRY	=	36.103 + 1.136X (0.108)	F = 110.153 R^2 = 0.948 X = capital formation in industry	N = 8
CONSTRCT	=	3.509 + 0.434X (0.033)	F = 175.179 R^2 = 0.951 X = total government development spending	N = 11
UTILITY	=	3.514 + 0.620X (0.131)	F = 22.331 R^2 = 0.736 X = lagged government development spending for utilities	N = 10
TRANSPRT	=	13.542 + 1.192 (0.111)	F = 115.521 R^2 = 0.935 X = government development spending for transportation sector	N = 11
BANKING	=	-18.902 + 0.077X (0.002)	F = 1587.452 R^2 = 0.993 X = lagged GDP	N = 12
COMMERCE	=	29.915 + 1.138X (0.071)	F = 257.679 R^2 = 0.977 X = capital formation in wholesale and retail trade	N = 9
HOUSING	=	3.912 + 0.845X (0.211)	F = 15.974 R^2 = 0.727 X = capital formation in housing	N = 9
SERVICES	=	-2.368 + 0.057X (0.002)	F = 598.810 R^2 = 0.980 X = lagged GDP	N = 14
PUB-SERV	=	14.193 + 0.538X (0.024)	F = 523.937 R^2 = 0.981 X = total government spending	N = 12

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1959-1973.

TABLE 6

Regressions Equations for Iraq[a]

AGRICUL	=	0.0 + 1.056X	Equation forced through origin r = 0.957 X = lagged output	
PETROL	=	5.474 + 0.950X (0.021)	F = 1993.180 R^2 = 0.997 X = petroleum exports	N = 10
INDUSTRY	=	19.264 + 2.009X (0.112)	F = 322.013 R^2 = 0.988 X = capital formation in industry	N = 10
CONSTRCT	=	-13.179 + 0.280X (0.025)	F = 127.581 R^2 = 0.955 X = total gross fixed capital formation	N = 10
UTILITY	=	-16.360 + 0.042X (0.002)	F = 507.468 R^2 = 0.992 X = total consumption	N = 8
TRANSPRT	=	-4.111 + 1.112X (0.053)	F = 443.305 R^2 = 0.989 X = lagged output	N = 8
COMMERCE	=	7.085 + 0.069X (0.007)	F = 99.093 R^2 = 0.971 X = total consumption	N = 10
BANKING	=	5.024 + 0.360X $(0.131)_1$ + 5.536X_2 $(1.643)_2$	F = 7.558 R^2 = 0.959 X_1 = lagged output X_2 = lagged capital formation in financial service	N = 8
HOUSING	=	-14.001 + 0.041X (0.007)	F = 32.136 R^2 = 0.865 X = consumption spending	N = 8
SERVICES	=	16.201 + 0.056X (0.014)	F = 16.201 R^2 = 0.794 X = consumption spending	N = 8
PUB-SERV	=	-3.929 + 0.497X (0.047)	F = 111.263 R^2 = 0.933 X = total current government spending	N = 10

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1955-1971.

TABLE 7

Regression Equations for Kuwait[a]

AGRICUL	=	0.0 + 1.033X	Equation forced through origin r = 0.87 X = lagged output	
PETROLM	=	29.796 + 1.034X (0.069)	F = 226.9 R^2 = 0.987 X = petroleum exports	N = 8
INDUSTRY	=	8.623 + 0.214X (0.051)	F = 17.321 R^2 = 0.776 X - lagged non-oil GDP	N = 8
SERVICES	=	109.211 + 0.836X (0.101)	F = 68.968 R^2 = 0.958 X = current government spending	N = 8
PUB-SERV	=	3.503 + 0.295X (0.016)	F = 360.496 R^2 = 0.992 X = current government spending	N = 8

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1965-1972.

TABLE 8

Regression Equations for Libya[a]

AGRICUL	= 0.0 + 1.0892X	Equation forced through origin r = 0.81 X = lagged output	
PETROLM	= 363.160 + 0.525X (0.296)	F = 3.157 R^2 = 0.441 X = petroleum exports	N = 7
INDUSTRY	= 14.030 + 0.674X (0.049)	F = 186.802 R^2 = 0.969 X = government development spending for industry	N = 8
UTILITY	= 1.103 + 1.080X (0.107)	F = 102.618 R^2 = 0.962 X = lagged output	N = 9
CONSTRCT	= 0.814 + 0.721X (0.044)	F = 264.614 R^2 = 0.721 X = total government development spending	N = 9
COMMERCE	= 5.520 + 0.095X (0.010)	F = 84.214 R^2 = 0.913 X = total consumption	N = 10
TRANSPRT	= 7.296 + 1.101X (0.182)	F = 36.55 R^2 = 0.859 X = lagged output	N = 8
BANKING	= 0.834 + 0.049X (0.011)	F = 20.891 R^2 = 0.777 X = petroleum revenues	N = 7
SERVICES	= 50.404 + 0.0234 (0.008)	F = 22.37 R^2 = 0.910 X = total government spending	N = 8
PUB-SERV	= 3.631 + 0.449X (0.091)	F = 24.092 R^2 = 0.828 X = total government spending	N = 8

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1958-1973.

TABLE 9

Regression Equations for Nigeria[a]

AGRICUL	=	28.880 + 1.015X (0.119)	F = 75.865 R^2 = 0.873 X = lagged output	N = 13
PETROL	=	-7.396 + 1.015X (0.022)	F = 2204.916 R^2 = 0.994 X = petroleum exports	N = 14
OTH-MINE	=	10.132 + 0.009X (0.001)	F = 43.801 R^2 = 0.785 X = total gross fixed capital formation	N = 14
INDUSTRY	=	34.694 + 0.304X (0.021)	F = 207.586 R^2 = 0.945 X = total gross fixed capital formation	N = 13
UTILITY	=	0.350 + 0.073X (0.011)	F = 46.911 R^2 = 0.810 X = capital formation in utilities	N = 13
CONSTRCT	=	10.002 + 0.536X (0.020)	F = 703.437 R^2 = 0.980 X = capital formation in the construction industry	N = 13
SERVICES	=	40.589 + 0.133X (0.013)	F = 104.30 R^2 = 0.905 X = lagged GDP	N = 13
TRANSPRT	=	45.342 + 0.257X (0.040)	F = 40.259 R^2 = 0.703 X = capital formation in the transportation sector	N = 13
MANPOWER	=	55.311 + 2.588X (0.633)	F = 16.724 R^2 = 0.603 X = government development spending for health and education	N = 13
PUB-SERV	=	102.931 1.683X (0.326)	F = 26.639 R^2 = 0.973 X = current government spending for public administration	N = 13

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1958-1973.

TABLE 10

Forecasting Equations for Qatar

AGRICUL	=	0.0 + 1.0689X	X = lagged output
PETROLM	=	83.5 + 1.033X	X = petroleum revenues
INDUSTRY	=	392.7 + 0.622X	X = lagged non-oil GDP
SERVICES	=	89.01 + 1.131X	X = current government spending

TABLE 11

Regression Equations for Saudi Arabia[a]

AGRICUL	=	929.028 + 3.301X (0.915)	F = 13.003 R^2 = 0.929 X = change in government spending for agriculture	N = 8
PETROLM	=	817.743 + 0.795X (0.011)	F = 5290.115 R^2 = 0.999 X = petroleum exports	N = 9
REFINING	=	0.0 + 1.14X	Equation forced through origin r = 0.93 X = lagged output	
INDUSTRY	=	191.218 + 0.075X (0.032)	F = 5.564 R^2 = 0.582 X = total fixed capital formation	
UTILITY	=	108.127 + 0.017X (0.003)	F = 26.063 R^2 = 0.867 X = total consumption	N = 9
CONSTRCT	=	375.315 + 0.199 (0.025)	F = 62.345 R^2 = 0.912 X = total government development spending	N = 9
COMMERCE	=	-137.186 + 0.125X (0.010)	F = 159.072 R^2 = 0.975 X = total consumption	N = 9
TRANSPRT	=	186.875 + 0.067X (0.008)	F = 65.284 R^2 = 0.942 X = lagged GDP	N = 9
B. & R.E.	=	346.337 + 0.041X (0.004)	F = 127.555 R^2 = 0.970 X = lagged GDP	N = 9
SERVICES	=	0.784 + 0.026X (0.003)	F = 91.0 R^2 = 0.958 X = total consumption	N = 9
PUB-SERV	=	925.099 + 0.137X (0.014)	F = 93.290 R^2 = 0.979 X = total government spending	N = 9

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1965-1973.

TABLE 12

Forecasting Equations for United Arab Emirates

AGRICUL	=	0.0 + 1.0494	X = lagged output
PETROLM	=	281.71 + 1.033X	X = petroleum revenues
INDUSTRY	=	606.77 + 0.214X	X = lagged non-oil GDP
SERVICES	=	112.7 + 1.131X	X = current government spending

TABLE 13

Regression Equations for Venezuela[a]

AGRICUL	= 627.429 + 0.476X_1 (0.293)	F = 2.633 R^2 = 0.945	N = 10
		X_1 = lagged output	
PETROLM	= 34621.276 + 0.565X (0.078)	F = 52.258 R^2 = 0.882	N = 10
		X = petroleum exports	
OTH-MINE	= 528.066 + 2.470X (0.861)	F = 528.066 R^2 = 0.733	N = 9
		X = lagged capital formation in the non-petroleum mining sector	
INDUSTRY	= 2008.737 + 3.589X (0.572)	F = 39.314 R^2 = 0.929	N = 9
		X = capital formation in industry	
REFINING	= -1552.698 + 0.306X (0.020)	F = 48.21 R^2 = 0.850	N = 9
		F = petroleum exports	
UTILITY	= 47.079 + 1.020X (0.258)	F = 15.665 R^2 = 0.887	N = 9
		X = lagged output	
CONSTRCT	= -550.354 + 0.227X (0.013)	F = 283.614 R^2 = 0.990	N = 9
		X = total gross fixed capital formation	
COMMERCE	= -910.352 + 1.238X (0.107)	F = 134.301 R^2 = 0.985	N = 9
		X = lagged output	
TRANSPRT	= -484.598 + 0.123X (0.007)	F = 272.463 R^2 = 0.993	N = 9
		X = lagged GDP	
SERVICES	= -838.356 + 1.174X (0.132)	F = 79.108 R^2 = 0.975	N = 9
		X = lagged output	
PUB-SERV	= 622.863 + 0.717X (0.053)	F = 179.450 R^2 = 0.984	N = 9
		X = current government spending	

[a] Dependent variable is always the sector's contribution to GDP. Estimated standard errors are reported in parentheses. N is the number of observations for the equation. All values are in local currency units. Period of data: 1965-1973.

TABLE 14

Regression Equations on Kuwait for U.A.E. and Qatar

PETROLM	=	101.39 + 1.033X (0.070)	F = 200.1 R^2 = 0.97 X = petroleum revenues	N = 7
INDUSTRY	=	8.623 + 0.214X (0.051)	F = 17.321 R^2 = 0.776 X = lagged non-oil GDP	N = 8
SERVICES	=	112.714 + 1.131X (0.101)	F = 125.642 R^2 = 0.977 X = current government spending	N = 8

APPENDIX D

Estimating Absorptive Capacity

INTRODUCTION

This appendix summarizes the assumptions and structures of the forecasting model utilized to generate CACI's forecasts of the medium-term ability of the oil-producing countries to absorb real goods and services. It discusses some key issues which had to be resolved, suggests a basic approach to the modeling effort, and elaborates crucial elements of the forecasting system. It is followed by a flow chart which presents the logic of the model.

MODELING ABSORPTIVE CAPACITY

The project required that the economic prospects of the 13 Organization of Petroleum Exporting Countries (OPEC) members be examined individually. However, the limited time frame of the study made it unreasonable to presume that each country examination could begin from scratch. Yet it was equally unreasonable to expect to apply a single, detailed forecasting system that was sufficiently flexible to be adapted to the features of each of the countries. The forecast system was structured as a series of compartmentalized but related sub systems. This segmentation made it possible to tailor the model to each country. Requisite changes to capture differences among them were contained within one (or more) of the subsystems, and the potential requirement that the entire model be "reinvented" as a result of any one change was avoided.

The second generation problem considered was the applicability of the "usual" forecasting assumptions to the projection of OPEC economies. The classic forecasting exercise employs historical information and assumes the future will resemble the past. The most reasonable assumption about the OPEC countries is that their futures will be something other than "scaled expansions" of past activity patterns. The likelihood of structural change and the short observation period since the rise in petroleum prices make the standard assumptions dangerous. As it is not sufficient to design a study that can, at best, confirm a departure from previous activity patterns, some allowance for structural changes must be incorporated within the projections. Unfortunately, the identification of new activity patterns is unlikely in light of the limited observation period since the increase in petroleum revenues.

At an elementary level, there is only one possible solution to the problem of structural change. Very simply, a judgment must be made. Guidance can be obtained from economic theory, from the historical experience of other countries compared to the OPEC members, and from recent information

about conditions within them. Granting the attempt to apply informed judgment to the best advantage, there still remains an important issue. Either judgment is applied to develop an algorithm that is then employed to dictate the structure of change through successive periods, or judgment is employed during each model period to identify the likely possibilities. The latter approach was preferred.

The third general issue to be considered was the treatment of government activities. It is possible to construct economic models that abstract from the role of the government, just as it is possible to focus on an unobtrusive government sector. Neither of these approaches seemed appropriate. First, the examination of development prospects and paths must consider social, political, and military influences. If an explicit and active government sector was developed, these influences could, in large part, operate as influences on the government. To the extent that these influences are only representable as qualitative variables, it would be better to limit the points at which they "enter the model." Incorporating qualitative influences in a quantitative framework is always difficult, but the task is generally easier if it is possible to trace the impact of the variables through the system as an aid to evaluate the total impacts consistently. If the influence of qualitative variables is diffused through the system, a consistent evaluation of their total effects becomes problematic.

A second reason to incorporate an active government sector derives from an obvious reality -- the governments of OPEC members receive and disburse the oil revenues. Again, it is possible to formulate a set of assumptions concerning the distribution of these revenues to other economic agents and avoid a decision-making government. However, the inclusion of a government that controls expenditures can substantially simplify the treatment of some classes of spending, particularly infrastructure development.

Granting the force of these two arguments in favor of an active government sector, the obvious drawback to modeling government activity is the difficult specification of behavioral assumptions to adequately depict the government's choice problem. The range of issues influencing government behavior must be restricted, but the choice of restrictions is a non-trivial problem. The only practical solution is to consider only the "important" influences and to employ an ex ante evaluation of the relative influence of different aspects of government behavior on the development process and the relative force of different issues on the OPEC governments to identify "importance."

These very general statements can perhaps be clarified by presenting a very simple characterization of the "problem" before the OPEC governments. Abstraction is rather severe in the characterization but the intent is not to specify an exact statement of the issues pertinent to all OPEC members -- only the highlights are included.

The most straightforward statement of the OPEC problem can best be made by appeal to the simple, one-commodity, neo-classical growth model. Omitting (in the interest of brevity) a full specification of the assumptions necessary to insure the existence of a solution, the basic relations are:

1. $Y(t) = C(t) + I(t)$
2. $I(t) = \dot{K}(t) + SK(t)$
3. $\dot{L} = gL$
4. $Y = F(K,L)$.

In order, these are: (1) the income identity, establishing the use of output for either consumption or investment; (2) the gross investment identity, establishing net investment (or capital accumulation) as the excess of gross investment over depreciation occurring at the constant proportional rate, S; (3) the growth of the labor force at the exponential rate, g; and (4) the production function establishing the technically efficient possibilities for employing capital and labor in production.

Defining $k = K/L$, taking time derivatives, and substituting from the above relations yield the fundamental differential equation of the model:

$$\dot{k} + c = f(k) - (g + S)k,$$

where lower case letters denote per worker magnitudes. In this form, the equation illustrates clearly that any improvement in development prospects (more capital per worker) and any consumption must come after setting aside a portion of production to offset depreciation and the growing labor force, otherwise the economy will deteriorate. As stated, however, the model is "open" in the sense that the division of the "surplus" between capital accumulation and consumption is not yet specified.

A variety of approaches determinate the consumption-accumulation issue. All recognize the identify between investment and saving, differences only appear in the specification of saving behavior. A common treatment is to assume that saving is related (proportionately) to total income. Having established this rule, the behavior of the economy is fully determined. It is then possible to investigate the optimum saving rate given a variety of goals or targets. A more interesting problem appears if the amoung of saving is not completely determined by total income.

Suppose attention is first concentrated on the amount of consumption that will occur and saving is treated as a residual. Set consumption at an arbitrary <u>fixed</u> level, c^*. The effect of this condition is shown in Figure 1. The model has two points at which there is no accumulation, at k_1 and k_2. Interestingly, only the second is a stable equilibrium. The position at k_1 represents a critical capital-labor ratio for the economy. If the actual capital stock is insufficient to achieve this ratio, impossible, deteriorating performance is inevitable. If there is to be any relief, resources from outside the economy must be made available. An argument along exactly these lines is often advanced in support of foreign aid. However, the government of an oil-producing country faces an analogous

problem -- petroleum revenues are the outside resources and the government's problem is to support consumption while ensuring that the phase of self-sustained growth of the non-oil economy is achieved prior to the termination of the revenue flow.

This conception of the process served as the basis of the model. First, the separation of the petroleum sector from the remainder of the economy can be supported by available information. Studies of selected OPEC economies have demonstrated that the relations or linkages (forward and backward) between the petroleum industry and other sectors of the economy are minimal. Consequently, the influence on the economy of different activity levels within the petroleum sector is small. Hence the petroleum sector as an "outside" generator of resources is not an improper view.

From statements by the OPEC governments, it appears to be the case that they are behaving as if the results of the model are known to them. Their concern to "diversify" in preparation for the depletion of their oil reserves and their desire to employ the revenues to improve immediately the standards of living of their citizens are expressions of the central problem of the model.

The assumption of a fixed consumption level can be overly static, but it can be amended easily. For example, $\dot{c}^* = ec^*$, is a method of increasing the consumption level over time. This equation complicates the model in that the differential equations are now required.[1] The interpretation, however, is not difficult. The increasing consumption level increases the critical capital-labor ratio over time. Nor is it particularly difficult to interpret a concern for increasing consumption and a commitment to consumption goals before accumulation. Consumption in the model

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[1] Additional assumptions are also required. Basically, there must be a limitation on the level of per capita consumption. A simple treatment would be a pre-set switch point at which the requirement that consumption targets be fulfilled before accumulation would be relaxed in favor of the usual saving-ratio approach.

is a proxy for all uses of output other than accumulation. Political, social, and military influences all serve to identify uses of income that are not directly productive.

Any adequate discussion of the OPEC problem begins to illustrate the impracticality of the simple model as a depiction of the government's concern. If the government were to apply the ideas of the model directly, a knowledge of the aggregate production function would be required.[2] The "planning" function is substantially more complex if the critical, take-off point is unknown and the government must monitor more directly observable variables in the economy and infer from these the likely relation of the economy's current position to the unknown, target level of accumulation.

Another complication for the government's planning activities is the uncertainty surrounding the level of petroleum revenues in each period and the number of periods during which the revenues will be available. An element of risk aversion could account for the government incorporating a safety margin into all exercises and could also account for efforts to extend the period of resource flow. Note that this latter notion can partially account for the observed behavior of OPEC members regarding continuing exploration and construction of productive capacity despite existing excess capacity.

Finally, some explanation of the government's failure to disburse all revenues in each period must be offered. The model suggests that any excess available after supporting consumption would be entirely employed to accumulate capital. An idea that is often advanced to account for the behavior is a portfolio interpretation of the government's acquisition of assets. If an alternative (to real capital in the economy) asset is

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[2] The question of existence of such a relation is not as difficult as one might expect provided the one-commodity specification is maintained. The correctness of neo-classical postulate in a multiple commodity world is problematic -- the possibility that output is not a monotone function of the ratio(s) of inputs must be admitted. These issues are acknowledged but otherwise passed over.

introduced, then the government would seek to equalize across assets the rates of return it receives. Should this not be possible (an imperfect capital market must exist) the government can, nevertheless, employ a part of its "surplus" resources to acquire an alternate asset rather than accumulate capital. However, if we accept as the principal intention of the government the development of the domestic economy, all diversions of resources to the alternate asset must either (1) be temporary, or (2) be the result of a judgment that the domestic economy can never generate an income stream to rival that produced by the alternative asset.

Arguing that the domestic economy can never generate an income stream greater than that available from an alternate asset requires an interpretation of absorptive capacity in an absolute sense. It must be the case that the economy can never generate a rate of return that equals those rates generated in other economies (the source of the alternative asset). Even if this condition does accurately describe the economy, the government must recognize and accept the impossibility of promoting domestic economic development. This set of circumstances seems sufficiently unlikely to rule out the notion of an absolute limit on absorptive capacity and consider instead the other case.

A temporary diversion of resources to a foreign asset can be explained by the more usual notion of absorptive capacity. All that is required is a constraint on the economy's ability to utilize additions to the capital stock in any one period. The nature of the constraint is almost unlimited. A very simple specification posits a cost associated with the transition from one capital-labor ratio to another. More specifically, assume the increment that can be installed and employed in any one period varies with the size of the existing capital stock and inversely with the amount of accumulation attempted. This is sufficient to account for observed behavior and is a relatively simple interpretation of absorptive capacity.[3]

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[3] Other possible explanations do exist. A government controlling (in part) the revenue stream it receives could choose to accelerate the receipt of revenues in the belief that the rate of return on foreign assets is greater than the rate of appreciation of petroleum in the ground. Appending a portfolio thesis can also suggest diversification rather than complete holdings in the form of unpumped crude. It should be pointed out, however, that both of these notions become more forceful if an absorptive capacity (adjustment cost) is also accepted.

The discussion thus far has been directed toward establishing some basic guidelines followed in developing the forecasting model for the project. Very little has been said directly about items or topics that are beyond the bounds of the study. One such limitation should be considered before attempting to implement these guidelines. Broadly stated, the project does not attempt to incorporate the influences of the "rest of the world" on any one economy under study. There are a many possibilities that could conceivably be included but practicality demands other wise. An important example of the type of restriction to be imposed is the creatment of petroleum revenues.[4]

The thrust of the argument in favor of an active government emphasized the planning role of the government. One planning function of the OPEC governments is the determination of oil price-quantity issues in relation to the possible uses of revenues and the effect of their decisions on the oil-consuming (importing) countries. While it is quite clear that a study directed toward the price-quantity problem as viewed by the OPEC governments would be valuable, the issues pertinent to that study are beyond the bounds of the current effort. Properly conceived, a study of the government's decision on pricing and production is an extremely complex process, a process requiring the results of the current investigation of absorptive capacity as one key item of required information. Consequently, the revenues available to the OPEC governments were set by assumption (see Appendix B) and attention concentrated solely on the disposition of revenues. As long as the revenue assumptions are consistent with the range of revenue estimates derived from studies of world petroleum markets, the project's estimates of imports can be valid. Subsequent investigators could then consider the future path of petroleum prices or the cohesiveness of OPEC in a more consistent manner than is currently possible.

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[4] Appendix B presents the petroleum revenue data used in this project.

The treatment of petroleum revenues is only one of many possible limitations to impose on the study. As an example of another, it is reasonable not to consider the export marketability of product lines being stimulated within OPEC economies. Completely ignoring the economic viability of different industries is equivalent to assuming that a competent and correct project evaluation has guided each spending program. While this may not be a particularly welcome assumption, the alternative is to conduct a project evaluation of each program, a clear impossibility. It would seem to be the case that each potential expansion of the topical breadth of the project must be evaluated in terms of (1) the influence of the particular topic on future developments, and (2) the possibility of capturing any important influences by exogenous (and informed) assumptions.

THE FORECASTING SYSTEM

Understanding the forecasting model requires a more specific statement of its generic structure. The statements regarding government planning and the response of the economy must be expanded. The first issue is the type of planning undertaken by the government and the method to be employed in a model to depict that process.

The first element of planning to consider is the time horizon employed by planning authorities. It is the case that all OPEC governments engage in medium-term planning. Unfortunately, it is equally clear that they are not entirely successful. Most of the governments' activities can be viewed as problem-solving exercises -- more effort is devoted to securing relief from previously unforeseen "bottlenecks" in the economy than to avoiding future impasses. There is no difficulty in appreciating the magnitude of the governments' tasks, but it remains true that the governments react to the performance of the domestic economy. In constructing a model of government activity, this implies that the planning horizon can be shortened drastically. It will be assumed that an adequate characterization of government behavior can be achieved by allowing one-period planning. The

government is assumed to establish goals and programs at the start of each period. For each subh decision, programs are then the outcome of evaluating those (possibly changing) goals in light of the performance of the economy during the previous period. Over time, the model operates as a succession of iterative steps.

Accepting the initial compartmentalization of government-economy, the next step is to consider the nature of the government sector. We are concerned here with the classes of policy instruments to be included. Most economic models portray the government as the controller of a limited set of policy instruments. The essential questions concern the manipulation of those instruments and their impact on the economies. For OPEC governments the available policy instruments tend to be rather limited. It is assumed that the crucial policy is the government's spending program and the important questions related to the influences on the formulation of that program.[5]

To start the identification of influences on spending, the basis goals and spending of the government can be resolved into four general types. First, the government attempts to promote an improved standard of living for the population in a direct, short-term effort (for example, development of productive capability is not to be included here). Second, the government expends resources to accomplish its political and military goals. Third, the government attempts to promote the accumulation of capital. And finally, the government tries to reduce the transition costs associated with development. Within each of these four groups of expenditures (or goals) a variety of programs can be specified. While a detailed listing is possible, it is better to consider a more limited set of activities and expand the possibilities only when considering a particular country. It will be considered sufficient to set two subclasses of programs within each major category.

Programs designed to improve the standard of living of the population can be divided into transfer operations and direct purchases of goods and

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[5] The implication of government spending for the economy is discussed in a subsequent section.

services. Transfer operations are distinguished by the government's relinquishing control over the actual use of funds. The particulars of the scheme do not matter. Thus, Kuwait's land purchase system and Saudi Arabia's negative head tax are both considered transfers.[6] A government program to provide public housing is an example of direct provision by the government of a consumption item.

The second class of programs includes the disbursement of revenues to promote the government's political, including military, goals. The broad statement, political goals, is to be restricted to include only foreign grants and loans. Obviously, any program could be considered an effort to achieve political goals. The intent is to allow for those disbursements that have no effect on the home economy.[7] Military spending is similarly considered to be a drain on the government's resources. It is distinguished from aid because it can influence the domestic economy. The acquisition of hardware (largely from abroad for OPEC members) has no effect on the home economy but the concommitant requirements for manpower and support items (for example, construction of bases) do draw upon the economy's production and resources.

The category of programs to promote the accumulation of capital is the potential source of greatest confusion. This group is intended to encompass the government's spending to acquire directly productive physical capital, and the government's extension of funds to finance accumulation by the private sector. The idea is to separate programs according to the identity of the economic agent dispensing financial assets to acquire

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[6] The inevitable appearance of ambiguity in classifying any one program is recognized at the outset. The Saudi Arabian program is but the first example. It could be argued that the program more properly belongs to the class designed to reduce transition costs because the Saudi economy faces manpower constraints and because the subsidy is granted to the parents of children and not solely to adults. In every case, the classification must depend on a judgment of the principal effect of the policy.

[7] Recall the previous assumption that spending in world commodity markets and subsequent effects on the home economy are not within the purview of study.

real assets. The confusion enters because the existence of public corporations subsidized by the government and the review of all loan applications tend to deny a clear separation. A further and perhaps more important issue concerns the classification of any one asset as directly productive. In many cases, "direct or indirect" can be forever argued. Recognizing this difficulty suggests that extreme concern should not be extended to a difficult assessment of a program's membership in this versus the last spending class.

The final category of spending includes those programs designed to reduce the transition costs experienced by the economy in moving along a development path. This category includes the bulk of the government's development program. Within this group, two program types are identified: expenditures devoted to the provision of (physical) infrastructure and expenditures devoted to the development of human capital. The largest two programs in the latter subgroup are health care and education.[8] In the former subgroup is the vast array of projects designed to improve transportation, communications, water for agriculture, water, and so forth.

Beyond identifying these groups of expenditures, little else can be established without reference to a particular country. There does remain, however, the problem of specifying the division of resources into the four groups. An idealized view of the process would posit the simultaneous consideration of all programs. A practical view would suggest a hierarchical structure and some progress can be made toward identifying the nature of an operational hierarchy. A few simple rules of thumb suffice. Suppose we allow the government an element of longer-term planning with respect to the development of human capital. A reasonably accurate statement of revenue requirements could then be formulated for the entire forecast period. Next, we assume the government monitors the economy to

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[8] Again, arguments are possible. The philosophical debate regarding health and education as consumption items is explicitly avoided. The concession to the consumption view is limited to an acknowledgement that spending for these purposes can be undertaken without a cost-benefit evaluation that considers only the productive contribution. Whether the government does in fact weight the consumption elements or simply decides with less than perfect information is not considered.

identify the nature of existing constraints on its performance to determine a rough estimate of the funds required to address the major problems (historical experience could assist this process). Then the government considers its own investment programs, its desired promotion of consumption, and finally the elements of aid and military spending to be undertaken. Lest the objections be too rapid, it is emphasized that informed judgment about any one country could easily alter the order in which the programs are considered. Similarly, informed judgment may suggest that some expenditure items, for example, military, can be extrapolated directly (or as some proportion) with little difficulty.

We assume that the first stage of the government's planning is an allocation of total expenditures for each of the four program types. The effective constraint on this first stage allocation is the amount of revenues available. The second stage of the expenditure problem is the identification of spending programs within the larger groupings. It is at this stage that the performance of the economy enters most directly. For example, the provision of capital and infrastructure is influenced by the past performance of the different sectors of the economy. The failure of a sector to achieve a desired growth rate can signal a requirement for increased expenditures in comparison to the previous allocation.

Assuming for the moment that the overall notion of the government sector's operation has been established, the "economy" sector of the model must be considered. Relatively little can be gained from any elaboration of governmental activities until the depiction of the economy is established and the linkages or channels by which government activities affect the economy are identified.

The requirements of the economic sector of the model can be stated without difficulty. The model must be capable of representing elements of traditional macro-economic demand ideas and at the same time recognize the supply constraints typically embedded in neo-classical economic models.

A justification for this demand is not difficult. Considering the government's activities vis-a-vis the economy, it has been argued that the government is a consumer or demander of the economy's output. At the same time, the government is attempting to alter the supply constraints of the economy. Hence, both aspects must be made to coexist within the framework of the economy model.

The first element of the economic model to consider is the specification of production. The neo-classical production relation is the basis for the description but only after some modification to avoid requiring information about the capital stock and the quantity of employed labor. The contribution of capital to production is to be assigned a dominant role. Additions to the capital stock in any sector are related to possible increases in output via an incremental capital-output ratio. Labor is treated as a derived demand and a potential constraint on production if the economy-wide requirements exceed the available supply. For one industry:

$$\Delta Q_t = f(\Delta K_{t-i}),\ i = 0,\ldots,\ I,$$

$$L_D = g(Q_t + \Delta Q_t),$$

where Δ denotes change, Q is the value of production, K is capital, and L_D is labor demand. The measurement of each period's change in the capital stock is to be represented by gross investment in the absence of information about depreciation. More than one previous period's capital accumulation is introduced to permit the specification of transition costs, for example, only a percentage of potential output from increased capital is realized during the period in which it is installed. The identification of labor demand is altered according to historical pattern of change in labor productivity.

Empirical forms of the relations may vary but a suggestion for each can be offered. The output relation can be:

$$\Delta Q_t = \sum_{i=0}^{I} \lambda_i \Delta K_{t-i},$$

under the assumption that a distributed lag is employed to estimate the λ_i, and I is selected according to a best fit criterion. The equation to determine labor productivity can begin as a simple time trend:

$$\left(\frac{Q}{L}\right)_t = b_0 + b_1 T,$$

also be expanded to and consider the educational status of the population.

Having derived the demand for labor on the part of each industry, the total demand must be compared to the available supply. If there is an excess supply of labor, no problem exists. An excess of demand requires some adjustment, a scaling down of the achieved outputs of the different industries. A variety of possible approaches can be suggested but no one can be selected as the preferred method on an a priori basis. However, as examples: (1) labor made available to each industry could be rescaled while maintaining the industry proportions; (2) the government's emphasis on different sectors (spending) could identify the proportions of total supply allotted to each industry; or (3) some industries may be assigned an amount or proportion of labor with the remaining industries treated as in (1) or (2).

In addition to labor, other factors function as constraints on the ability of the economy's sectors to generate output. As an example, the output capability of the transport sector can limit the realized outputs of other sectors. For some of the OPEC economies it is possible to be guided by input-output tables to identify the derived demand for transport services arising in other sectors. In any case, the demand for transport can be introduced by borrowing the relations of interest from

countries reporting the necessary data. The applicability of another country's experience to any given country is of course open to question. However, an element of refinement (yet nonetheless an approximation) can be accomplished by adjusting transport demands to reflect the geographic dispersion of centers of economic activity. If total demands for transport exceed the capacity of the sector, an adjustment process analogous to that for labor must be applied.

In essence the determination of the potential outputs of the economic sectors requires at worst an iterative search for a solution in a manner analogous to a programming problem. In the best case the full solution to the model can be identified and the iteractive process of checking all constraints can be avoided. In either case, the determination of potential production is only one element of the problem. The product demands must also be considered.

Conceptually, the demand issues are exactly the issues of a Keynesian model of an economy. Unfortunately, the economic accounts of most OPEC countries will not easily support the usual methodology. Two factors, however, serve to reduce the difficulty of the problem. First, consumption spending can be adequately treated because almost all OPEC countries report a fairly recent survey of consumption patterns. And second, the major items of government spending can be reduced to the direct employment of labor and spending for imports. The investment goods sector of most of the economies is non-existent -- any spending for accumulation must result in imports. The only exception, and it is a major exception, is the government's purchases from the construction sector. Domestic provision of construction materials is possible, and fortunately, most of the countries report rather detailed production data for these items. Hence, it is possible to trace the excess demands to be fulfilled by imports.

The remaining spending category is by far the most difficult to specify. Investment spending can be assumed to respond to any provision by the

government of subsidized loans. But the pattern of private investment is not as easily considered. The way to specify an industry pattern that seems most reasonable is a carefully described, judgmental identification. Items influencing the judgment include the expenditure patterns of government and the resource conditions of the economy. The most recent investment pattern(s) can be employed as indicators of the profitability of different sectors.

THE FORECASTING PROGRAM

A general flow chart of the logic and sequence of operations in the computer program used to generate the estimates discussed in the 13 country chapters is presented in this section. The program is written in General Electric FORTRAN and runs on a time-sharing basis in less than 32,000 bytes of memory. As presently constituted, the program requires five different data files: (1) a file with petroleum production and revenues; (2) a file with time-series economic variables; (3) a file with time-series governmental spending and revenue variables; (4) a file with regression estimates developed from the equations for each country as presented in Appendix C; and (5) a control file with information on the number of sectors in the economy for each country for which data are held, the last year for which different types of data are available, exchange rates, and information on petroleum prices. Each of the five files exists for each of the 13 OPEC countries.[9]

[9] Additional technical documentation on the forecasting program, including an annotated program listing, has been deposited with the contract monitor, Mr. Warren Reynolds (INR/DDM/XR). A copy of all programs and data decks used in the study has also been deposited with Mr. Reynolds.

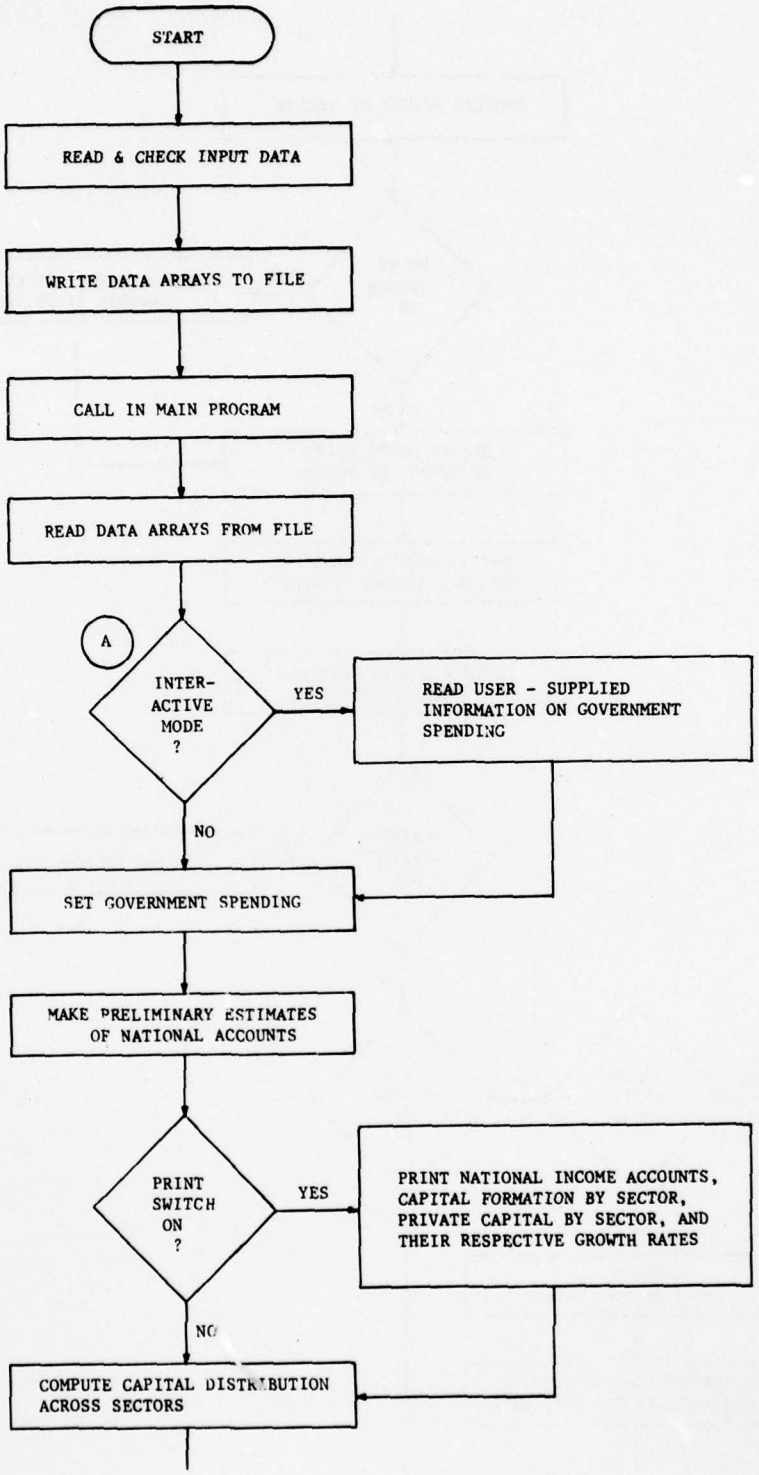

Figure 1. The Forecasting Program Flow Chart, Part 1

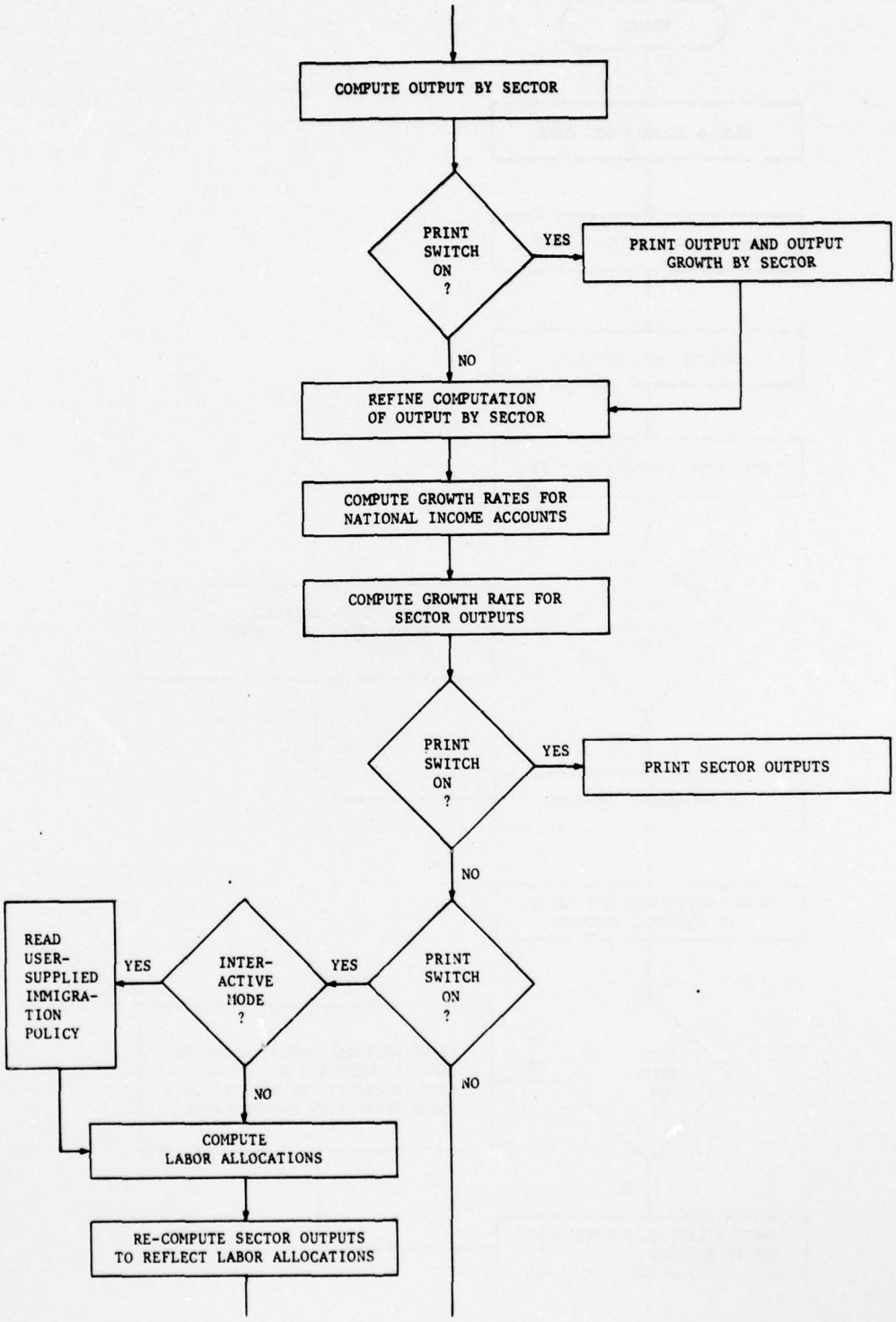

Figure 2. The Forecasting Program Flow Chart, Part 2

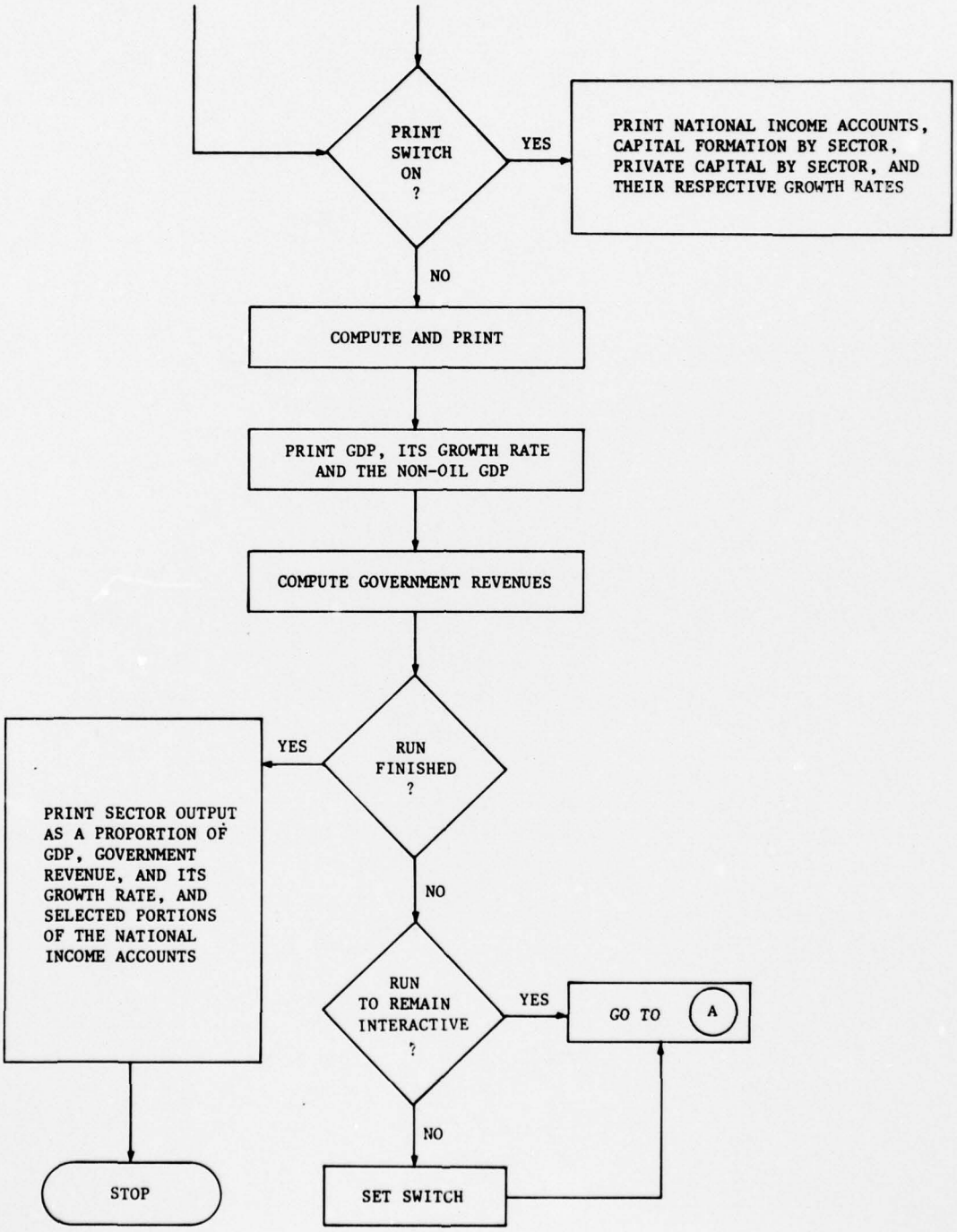

Figure 3. The Forecasting Program Flow Chart, Part 3